

UNIVERSITY OF OREGON
APPLIED INFORMATION MANAGEMENT

Presented to the Interdisciplinary
Studies Program:
Applied Information Management
and the Graduate School of the
University of Oregon
in partial fulfillment of the
requirement for the degree of
Master of Science

Framing a Collaborative Enterprise Architecture Governance Program within the Context of Service-Oriented Software Systems Development

CAPSTONE REPORT

Mark McClure
Enterprise Technology Architect
The Regence Group

University of Oregon
Applied Information
Management
Program

March 2007

722 SW Second Avenue
Suite 230
Portland, OR 97204
(800) 824-2714

Approved by

Dr. Linda F. Ettinger

Academic Director, AIM Program

Abstract
for
Framing a Collaborative Enterprise Architecture Governance Program
Within the Context of Service-Oriented Software Systems Development

The chief enterprise architect must employ different methods to govern enterprise architecture (The Open Group, 2005) and service-oriented architecture (Malinverno, 2006). Results from a content analysis of selected materials published between 2002 and 2006, help to form a framework of four artifacts including a glossary, conceptual model, a set of causal loop diagrams and a guide for a collaborative enterprise architecture governance program. The framework is designed to support the analysis, design and development of service-oriented software systems.

Table of Contents

CHAPTER I – PURPOSE OF STUDY	1
BRIEF PURPOSE	1
FULL PURPOSE	3
LIMITATIONS TO THE RESEARCH.....	8
PROBLEM AREA	10
SIGNIFICANCE OF THE STUDY	12
CHAPTER II - REVIEW OF REFERENCES.....	14
KEY REFERENCES ON RESEARCH METHODOLOGY	14
KEY REFERENCES ON ENTERPRISE ARCHITECTURE.....	17
KEY REFERENCES ON EA GOVERNANCE & SOA GOVERNANCE.....	19
CHAPTER III - METHOD	24
LITERATURE COLLECTION	24
DATA COLLECTION AND ANALYSIS	25
DATA PRESENTATION	28
CHAPTER IV – ANALYSIS OF DATA	31
CHAPTER V – CONCLUSIONS.....	35
GUIDE TO ENTERPRISE ARCHITECTURE GOVERNANCE	36
GLOSSARY OF ENTERPRISE ARCHITECTURE GOVERNANCE TERMS.....	40
APPENDIX A – DEFINITIONS OF TERMS	42
APPENDIX B – DATA SET FOR CONTENT ANALYSIS	62
APPENDIX C – ENTERPRISE ARCHITECTURE CONCEPTS	63
APPENDIX D – ENTERPRISE ARCHITECTURE ELEMENTS	69
APPENDIX E – CROSS GOVERNANCE INTERDEPENDENCIES.....	76
BIBLIOGRAPHY	86

List of Figures

FIGURE 1: ENTERPRISE ARCHITECTURE CONCEPTS	28
FIGURE 2: ENTERPRISE ARCHITECTURE ELEMENTS	29
FIGURE 3: CROSS GOVERNANCE INTERDEPENDENCIES	29
FIGURE 4: TEMPLATE FOR GUIDE TO ENTERPRISE ARCHITECTURE GOVERNANCE	30
FIGURE 5. ENTERPRISE ARCHITECTURE GOVERNANCE CONCEPTUAL MODEL	37
FIGURE 6. ENTERPRISE ARCHITECTURE GOVERNANCE CAUSAL LOOP DIAGRAMS	39

List of Tables

TABLE 1. ENTERPRISE ARCHITECTURE CONCEPTS	63
TABLE 2. ENTERPRISE ARCHITECTURE ELEMENTS	69
TABLE 3. CROSS GOVERNANCE INTERDEPENDENCIES	76

Chapter I – Purpose of Study

Brief Purpose

The purpose of this study is to create a framework for a collaborative enterprise architecture governance program (Jaffarian, 2005, p. 29), built on a conceptual model and a systems thinking tool (Pegasus Communications, 2006b). The framework is designed to support the analysis, design and development of service-oriented software systems (Zimmermann, Krogdahl, & Gee, 2004).

In this study, enterprise architecture is used in the sense defined by Lapkin (2006) as “the process of translating business vision and strategy into effective enterprise change by creating, communicating and improving the key principles and models that describe the enterprise's future state and enable its evolution” (p. 9).

Governance “is essentially about ensuring that business is conducted properly. It is less about overt control and strict adherence to rules, and more about guidance and effective and equitable usage of resources to ensure sustainability of an organization's strategic objectives” (The Open Group, 2005). Within the context of information technology (IT) and as used in this study, governance is “the assignment of decision-making rights and accountabilities regarding behavior in the desirable use of IT” (Dreyfuss, 2003, p. 2). In the hierarchy of governance structures, IT governance encompasses enterprise architecture governance, which is “the practice and orientation by which enterprise architectures and other architectures are managed and controlled at an enterprise-wide level” (The Open Group, 2005).

The audience for this study is the group of senior-level IT leaders accountable for all aspects of enterprise architecture, including governance, in organizations that have advanced to the second stage of architecture maturity, as defined by Ross, Weill and Robertson (2006, pp. 69-

89). For purposes of this study, these individuals include Chief Information Officers, Vice Presidents of IT Strategy, Architecture and Planning, and Chief Enterprise Architects.

The larger method of study is literature review (Leedy & Ormond, 2005, pp. 64-81). The resources used in this study are selected from among those published between 2002 and 2006. This date range is selected to ensure that the published materials address the advances that have occurred in the enabling specifications, technologies and methods used in the analysis, design and development of service-oriented software systems. Once the data is collected, the literature is evaluated and categorized based on aspects of enterprise architecture governance, as defined by The Open Group (2005). Then, selected materials are analyzed using the eight-step conceptual analysis approach defined by Palmquist et al. (2006). This approach is a form of content analysis, which is “a detailed and systematic examination of the contents of a particular body of material for the purpose of identifying patterns, themes, or biases” (Leedy & Ormond, 2005, p. 142). Specific objectives for the conceptual analysis process include the following:

- Identify the variety of ways concepts related to enterprise architecture are used in the literature.
- Identify the elements of enterprise architecture used to support an enterprise architecture governance program.
- Identify the interdependencies between enterprise architecture governance and service-oriented architecture (SOA) governance, as concepts are described by Woolf (2006) and Mitra (2005).

Raw results from the data analysis, which reflect the three objectives examined above, are collected and presented in a set of tables. Then, the results are analyzed again and presented in a final outcome study. This second level of analysis leads to the creation of the primary outcome

of the study—a set of artifacts that, when used together, provide a framework for a collaborative enterprise architecture governance program (Jaffarian, 2005, p. 29).

Full Purpose

Over the last 50 years, the role of information technology (IT) has steadily increased its reach in organizations. As Luftman and Bullen (2004) explain, “From the early days of the computer as the simple ‘number cruncher’ supporting the accounting and financial functions in a business, technology has expanded its role and now supports the entire range of business operations, including the external activities that occur in dealing with suppliers and customers” (p. 5).

Today, the support role of IT extends to business strategy. IT can “provide and sustain competitive advantage for an organization that decides to pursue the use of IT as an integral part of the business strategy” (Luftman & Bullen, 2004, p. 2). This role of IT requires alignment between business strategies and IT strategies. “One of the most important missions for IT management in the 21st century is to be *architects* of alignment linking business and IT. The metaphor of architecture is chosen because IT strategy is *not* just about technology—it is about the purposeful creation of *integrated* environments that leverage human skills, business processes, organizational structures, and technologies to transform the competitive position of the business” (Luftman & Bullen, 2004, p. 25).

Ross, Weill and Robertson (2006) contend that the alignment of business and IT strategies is necessary to support a *foundation for execution* (pp. 3-8). The authors maintain that to build an effective foundation for execution, companies must develop and apply three key disciplines: an operating model, enterprise architecture, and an IT engagement model. In this study, the focus is

on the discipline of enterprise architecture, specifically the elements needed to support an enterprise architecture governance program.

The audience for this study is the group of senior-level IT leaders accountable for all aspects of enterprise architecture, including governance, in organizations that have advanced to the second stage of architecture maturity, as defined by Ross, Weill and Robertson (2006, pp. 69-89). In the second stage of architecture maturity, known as Standardized Technology architecture, “IT efficiencies are realized through technology standardization, and in most cases, increased centralization of technology management” (Ross et al., 2006, p. 71). For purposes of this study, the audience members include Chief Information Officers, Vice Presidents of IT Strategy, Architecture and Planning, and Chief Enterprise Architects. Furthermore, it is assumed that the Chief Enterprise Architect reports to the Vice President of IT Strategy, Architecture and Planning, who in turn reports to the Chief Information Officer.

This study is designed as a literature review of selected materials pertaining to enterprise architecture, enterprise architecture governance, service-oriented architecture, service-oriented architecture governance and systems thinking tools. The purpose of a literature review is to draw on existing theories and prior research studies to identify a research problem and accompanying hypotheses and questions (Leedy & Ormond, 2005, p. 65). Once the material is collected, the literature is evaluated and categorized based on the following aspects of enterprise architecture governance:

1. IT organizational structure, IT culture and architecture maturity: The purpose of this category is to organize materials that explain how the IT organizational structure, IT culture and state of architecture maturity can influence the enterprise architecture

governance program (Young, 2005, pp. 2-6). This material forms part of the base of the data set for content analysis.

2. IT project management: The purpose of this category is to organize materials that show the relationship between enterprise architecture governance and IT project management (Bittler & Kreizman, 2005, pp. 10-12), (Leganza, 2003, p. 1), (Burke, 2006a). This material forms part of the base of the data set for content analysis.
3. Enterprise architecture elements (e.g., enterprise architects, architecture principles, processes, frameworks, models, patterns, standards, tools): The purpose of this category is to organize materials that demonstrate how enterprise architecture elements shape enterprise architecture governance. Focus is given to those elements essential to support *minimalist* (Malan & Bredemeyer, 2002) or *good enough* (Schulman, 2003) approaches to enterprise architecture. This material forms part of the base of the data set for content analysis.
4. System development architectures and methodologies: The purpose of this category is to organize materials that show the interactions and dependencies between enterprise architecture governance and selected system development architectures and methodologies. The main subcategories, many overlapping, include Service-Oriented Architecture (Organization for the Advancement of Structured Information Standards, 2006b), Model-Driven Architecture (MDA) (Frankel et al., 2003, pp. 1-14), Model-Driven Development (Michiels, Snoeck, Lemahieu, Goethals, & Dedene, 2003, p. 59), Object-Oriented Analysis and Development (OOAD) (Blechar & Norton, 2006), Component-Based Development (CBD) (Blechar & Norton, 2006), and Commercial-Off-

The-Shelf (COTS) systems (Lymer, Liu, & Easterbrook, 2005). This material forms part of the base of the data set for content analysis.

5. Systems thinking tools: The purpose of this category is to organize materials pertaining to selected systems thinking tools (Pegasus Communications, 2006b). This material is used to design one part of the final outcome of the study, a set of causal loop diagrams for presentation to the audience.

Once the literature is organized, selected materials are analyzed using the eight-step conceptual analysis approach as defined by Palmquist et al. (2006). The approach fits within a larger method of examination known as content analysis, which is “a detailed and systematic examination of the contents of a particular body of material for the purpose of identifying patterns, themes, or biases” (Leedy & Ormond, 2005, p. 142). Another definition of content analysis is given by Krippendorff, who states that “Content analysis is a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use” (2003, p. 18).

Specific objectives for the conceptual analysis process include the following:

- Identify the variety of ways concepts related to enterprise architecture are used in the literature. An example of one way is the relationship between IT strategic planning and enterprise architecture. Weiss, Rosser and Blanton (2005) point out that “IT strategic planning and enterprise architecture must be aligned, agile and responsive – not disconnected, bureaucratic and internally focused” (p. 3).
- Identify the elements of enterprise architecture used to support an enterprise architecture governance program. An example of an enterprise architecture element is the process an organization follows for *sun-setting* technologies.

- Identify the interdependencies between enterprise architecture governance and service-oriented architecture governance, as concepts are described by Woolf (2006). An example of interdependency is the role the Enterprise Architecture group serves supporting enterprise architecture governance, as well as service-oriented architecture governance. Windley (2006) states “Many organizations create a center of excellence or some other group in the enterprise architecture group to provide resources and guidance, to serve as a repository for best-practice information, and to operate tools that support the SOA governance process” (p. 32). A configuration management database (CMDB), which can be used to address enterprise architecture governance as well as service-oriented architecture governance, also represents an example of an interdependency. By definition, a CMDB “is more than an asset or inventory database. It expresses the component dependencies and hierarchical relationships that make up an IT service delivered to the business or to IT customers” (Colville, 2006, p. 3).

The results of this conceptual analysis are presented in a series of three tables, one for each analysis objective (see Figures 1, 2 and 3). Then, the results are analyzed again and presented in a final outcome study. This second level of analysis leads to the creation of the primary outcome of the study—a set of four artifacts that, when used together, provide a framework for a collaborative enterprise architecture governance program (Jaffarian, 2005). The artifacts include a preliminary glossary of enterprise architecture terms, a conceptual model, a set of causal loop diagrams, and a template for a guide to enterprise architecture governance. In this case, the term *framework* is used as “a basic conceptional [sic] structure (as of ideas)” (Merriam-Webster Online Dictionary, 2006b) and the term *collaborative* means “to work jointly with others or together especially in an intellectual endeavor” (Merriam-Webster Online Dictionary, 2006a).

The enterprise architecture governance framework is designed for use by the chief enterprise architect. The chief enterprise architect is “responsible for leading the program to develop, maintain, govern and evolve the enterprise architecture across the enterprise. The chief enterprise architect is also responsible for defining the enterprise architecture process and the architecture review process, as well as for leading the effective integration of these processes with other, related business and IT processes” (Handler & Weiss, 2006, p. 3).

The enterprise architecture governance framework is specifically designed to support the analysis, design and development of service-oriented software systems. Service-oriented software systems utilize service-oriented architecture, which the Burton Group defines as “a design style for building flexible, adaptable distributed-computing environments. Service-oriented design is fundamentally about sharing and reuse of functionality across diverse applications” (Kobielus, 2004, p. 7).

Limitations to the Research

The resources used in this study are selected from among those published between 2002 and 2006. This date range is selected to ensure that the published materials address the advances that have occurred in the enabling specifications, technologies and methods used in the analysis, design and development of service-oriented software systems. During this date range, for example, the World Wide Web Consortium (W3C) (2006b) published new and updated standards and specifications related to the Extensible Markup Language (XML), Web Services Description Language (WSDL), Simple Object Access Protocol (SOAP), Resource Definition Framework (RDF), to name a few. Another significant event that is shaping service-oriented software system development occurred in August 2006, when the Organization for the

Advancement of Structured Information Standards (OASIS) (2006b) published the first version of the Reference Model for Service Oriented Architecture. These advances, coupled with the rapid application *speed to market* pressures software developers now face, have presented new challenges for managing enterprise architecture governance.

In addition to excluding materials published prior to 2002, this study also excludes items that are promotional in nature or reflect significant commercial or personal bias.

The professional and association literature referenced in this study is from the following sources:

1. Association for Computing Machinery (ACM)
2. Institute of Electrical and Electronics Engineers (IEEE)
3. Gartner Research and META Group (acquired by Gartner Research)
4. Forrester Research and Giga Research (acquired by Forrester Research)
5. The Burton Group
6. The Corporate Executive Board and the CIO Executive Board and the Enterprise Architecture Executive Council
7. The Open Group
8. The World Wide Web Consortium (W3C)
9. The Organization for the Advancement of Structured Information Standards (OASIS)
10. International Business Machines and Rational Software (acquired by IBM)

The first six set of sources listed restrict access to full text materials based on membership, which the researcher either currently has, or had previously when the materials were collected.

The quality and validity of the non-commercial information available from each of these sources is generally high, as evidenced by the fact that authors must comply with ethical

standards and adhere to strict submission requirements. Published works are reviewed by peers and cited. For these reasons, the author name(s) and date of publication are the primary selection criteria applied.

The academic databases referenced in this study include *Academic Search Premier*, *Business Source Premier* and *Web of Science*. Materials selected from these databases include professional journals, conference proceedings, lecture notes and computer-related trade periodicals. The quality and validity varies among these sources, so only cited materials are used in this study so that readers can track down sources when in question.

The focus of this study is limited to the aspects of enterprise architecture that have a bearing on governance activities related to service-oriented analysis, design and development. The organizing categories used for data analysis, presented earlier, reflect the limits to the research.

The content analysis method, described earlier, is selected as the preferred data analysis approach for three main reasons:

1. Much of the data collection can be performed using online resources
2. The method is practical and can be achieved within the allowed study period
3. The content analysis method enables measures to be taken to ensure that the process is as objective as possible, and that the data is valid and reliable.

Problem Area

To develop, manage and govern enterprise architectures, IT organizations customarily employ a variety of enterprise architecture elements (e.g., enterprise architects, architecture principles, processes, frameworks, models, patterns, standards and tools). Traditionally, the approach to enterprise architecture governance has been *heavy-handed* (Burke, 2006b, p. 1). Enterprise architects have adopted rigid decision-making positions and operated in an oppressive

manner. In the last few years, however, enterprise architects have been advised to adopt *minimalist* and *good enough* approaches to managing and governing enterprise architecture. Malan and Bredemeyer (2002) recommend a *Less is More* approach (p. 48), and Schulman (2003) claims that *good enough* architecture represents a more-pragmatic view as an approach to an overall architecture concept. The focus is on agility and changeability, with a rapid response to business and technology architecture” (p. 2).

In contrast to the *minimalist* and *good enough* approaches to managing and governing enterprise architecture described above, service-oriented architecture requires strict controls. As Mitra (2005) explains, “It is of paramount importance that an enterprise that is strategizing around SOA needs an efficient governance mechanism. SOA governance is more than just providing governance for SOA efforts—it is how IT governance should operate within an enterprise that has adopted SOA as its primary approach to enterprise architecture” (Mitra, 2005). Windley (2006) points out that “Counterintuitive as it may seem, SOA requires more organizational discipline than previous development models. Your intuition might tell you that flexibility results from fewer rules, not more, but that’s not the case” (2006, p. 29).

As key participants in both enterprise architecture governance and service-oriented architecture governance activities, enterprise architects today must reconcile these seemingly opposite approaches to governance. This is the problem area this study addresses.

Significance of the Study

Although individual domain architectures have changed significantly over the years to keep pace with advances in technology, the concept of enterprise architecture has been recognized since the late 1970's (Yourdon & Constantine, 1979).

In a study of 24 large corporations, the Enterprise Architecture Executive Council (EAEC) (2005) found that enterprise architecture plays a key role supporting business strategy. In their study, the EAEC found that in the majority of the companies they surveyed, the central enterprise architecture groups were drivers for IT strategic planning and investment prioritization, enterprise application blueprinting, and application portfolio management (p. 8). The Best Practices Council for Architecture and Planning Executives at Gartner Research also identified the important role enterprise architecture plays supporting business strategy. "In today's hyper-connected business environment, the role of enterprise architecture in supporting business strategy has never been more important. Enterprise architecture promises organizations opportunities to improve business processes, develop new business models and increase organizational agility" (2004, p. 4).

In the 2000s, driven by the need to support the hyper-connected business environments defined above, commercial-off-the-shelf (COTS) systems and components, which "enable rapid development of [software] products with significant capabilities in a short time" (Boehm, 2006, p. 20) are continuing to rise in popularity. Software developers also continue the trend toward rapid application development using specialized software analysis, design and development methods and tools (Boehm, 2006, p. 19). To meet time-to-market-driven demands, there is also a trend to systematically reuse existing software models, designs and implementations (Schmidt & Buschmann, 2003, p. 694).

Finally, to meet the needs for greater business agility and software system reuse, IT organizations today are moving to service-oriented architectures, which are “capable of supporting rapid change through the assembly of software services and the orchestration of components” (Blechar & Norton, 2006, p. 2). Gartner Research predicts that “By 2010, at least 65 percent of large organizations will have more than 35 percent of their application portfolios SOA-based, which is up from fewer than 5 percent of organizations in 2005 (0.8 probability)” (Malinverno, 2006). External service providers and COTS systems vendors are also applying SOA development practices by “beginning to unbundle their ‘templates’ and packaged solutions into more-granular services and components for sale as software as a service (SaaS)” (Blechar & Norton, 2006, p. 2). The key role enterprise architecture plays supporting business strategies, which increasingly rely on service-oriented and COTS systems, emphasizes the need for enterprise architecture governance. In a 2006 *Briefing for Chief Information Officers*, the Enterprise Architecture Executive Council reported that among its members, 37% identified architecture governance (standard setting and enforcement) as an urgent challenge (p. 7).

Chapter II - Review of References

The Review of References section presents an annotated bibliography, in alphabetical order, of key references used to develop this research study. The key references pertain to both content and method. Each reference entry includes a description of how the source is used to support this research study, and the criteria used to select the reference. The selection of each reference is determined by one or more of the following criteria:

- The number of authors that have previously cited the reference
- The stature of the authors that have previously cited the reference
- The significance of the publication source

Selected key references are organized into the following categories:

- References that describe the research methodology
- References on enterprise architecture
- References on enterprise architecture (EA) governance and service-oriented architecture (SOA) governance

Key References on Research Methodology

Anderson, V., & Johnson, L. (1997). *Systems Thinking Basics, From Concepts to Causal Loops*. Waltham, MA: Pegasus Communications, Inc.

This publication, written in a workbook format, explains how to create behavior over time graphs and causal loop diagrams, two types of systems thinking tools.

A set of causal loop diagrams is developed as an outcome of this study to illustrate the dynamic relationships among some of the variables that influence enterprise architecture governance and service-oriented architecture governance.

Pegasus Communications, publisher of the *Systems Thinking Basics* workbook and other systems thinking instructional materials, also sponsors conferences on systems thinking. The *Systems Thinking Basics* workbook is used in the University of Oregon Applied Information Management Program, as well as in other university programs that offer classes on systems thinking.

Leedy, P., & Ormond, J. (2005). *Practical Research: Planning and Design* (8 ed.). Upper Saddle River: Pearson Education, Inc.

This book is used as a guide to frame the research design for this study. In Chapter 4, *Review of the Related Literature*, Leedy and Ormond provide useful techniques for finding, collecting and organizing research materials. In Chapter 7, *Qualitative Research*, Leedy and Ormond describe the content analysis method at a high level.

In this study, the techniques provided by Leedy and Ormond in Chapter 4 are used to develop the section on literature collection. The Chapter 7 overview of the data analysis method is used, along with additional materials from other sources, to develop the section on data collection and analysis.

Practical Research: Planning and Design is a primary textbook used in many university research classes, and frequently cited as a key resource in research studies. The late Paul Leedy, who taught at American University and authored several books on reading instruction, wrote the first six editions of this book. In addition to co-authoring this book, Jeanne Ormrod, who retired

from teaching at the University of Colorado and the University of New Hampshire, is the author of several books on educational psychology.

Palmquist, M., et al. (2006). Content Analysis. Writing@CSU. Colorado State University Department of English. Retrieved October 2, 2006, from <http://writing.colostate.edu/guides/research/content/>

Content analysis was selected as the data analysis methodology for this study because, as Krippendorff (2003) states, “Content analysis is a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use (p. 18). The Content Analysis guide by Palmquist et al, which is one of several online writing guides supported by Colorado State University (CSU), provides an overview of the content analysis research methodology. The publication covers the history and uses of content analysis, an overview of conceptual analysis and relational analysis and their associated methodologies, an explanation of the advantages and disadvantages of using content analysis as a research methodology, examples of real and hypothetical studies that use content analysis, key terms and an annotated bibliography of resources used in the guide. The eight-step approach for conducting conceptual analysis, described in the Content Analysis guide, is followed in the Method section of this study. The eight-step approach is particularly valuable because it provides a way to lay out and document the data analysis process in a manner that is both transparent and easily repeatable.

A search on the World Wide Web for the terms *CSU Online Writing Center* and *Writing@CSU* shows that the Content Analysis guide is used as a resource by researchers from universities and professional associations. Dr. Palmquist, who directs development of the Writing@CSU Web site, is a Professor of English at CSU. He is a University Distinguished

Teaching Scholar, the Director of CSU's Institute for Learning and Teaching, and Co-Director of CSU's Center for Research on Writing and Communication Technologies. Dr. Palmquist has published four books and written articles that have appeared in journals including *Computers and Compositions*, *Written Communication*, *IEEE Transaction on Professional Communication*, *Engineering Education*, *Kairos*, and *Social Forces*, as well as in edited collections.

Key References on Enterprise Architecture

Handler, R., & Weiss, D. (2006). Role Definition and Organization Structure: Chief Enterprise Architect (No. G00138141): Gartner Research.

In this paper, Handler and Weiss define the skills, knowledge, experience, responsibilities and related organizational relationships of the chief enterprise architect. In addition, Handler and Weiss provide representative enterprise architecture organization structures to show a typical traditional reporting structure, as well as a new, alternative team structure for the enterprise architecture organization.

Because the outcome of this study is designed for use by the chief enterprise architect, the definition of the role is particularly relevant. This reference source is selected as part of the set of materials used for coding during data analysis.

The source for this reference is Gartner, a highly regarded independent IT research and consulting company. "The Company consists of Gartner Research, Gartner Executive Programs, Gartner Consulting and Gartner Events. Founded in 1979, Gartner is headquartered in Stamford, Connecticut, U.S.A., and has 3,700 associates, including 1,200 research analysts and consultants in 75 countries worldwide" (Gartner Research, 2007). The authors of this paper, Robert Handler (Research VP) and Deborah Weiss (Research Director), are both responsible for coverage of

enterprise architecture at Gartner Research. Both have authored, or co-authored, other Gartner Research papers on enterprise architecture subjects, many of which are cited by other Gartner analysts.

Ross, J. W., Weill, P., & Robertson, D. C. (2006). Enterprise Architecture as Strategy: Creating a Foundation for Business Execution. Boston: Harvard Business School Press.

The concept of architecture maturity, as described in this book by Ross, Weill and Robertson, is used to qualify the state of organizations in this study. In Chapters 4 and 5, the authors describe how organizations that move through four stages of architecture maturity can learn to apply management practices to leverage the benefits of enterprise architecture. Included among the management practices, at each stage of architecture maturity, are enterprise architecture governance processes.

The notion of architecture maturity is used in the *Purpose* section of this study.

The authors of this book are recognized experts in the field of enterprise architecture, as evidenced by their professional positions. Jeanne Ross is a Principal Research Scientist at the MIT Sloan Center for Information Systems Research (CISR), Peter Weill is the Director of the MIT Sloan CISR and MIT Sloan Senior Research Scientist and David Robertson is a Professor at the International Institute for Management Development (IMD International), located in Lausanne, Switzerland.

Key References on EA Governance & SOA Governance

Jaffarian, T. (2005). Enterprise Architecture Governance: Gartner Research.

This presentation summarizes the findings of a case profile research study conducted by the *Best Practices Council for Architecture and Planning Executives* at Gartner Research. Included among the summarized results from the study are case study examples of the following:

- Key elements of a successful enterprise architecture governance program (objectives, processes)
- Enterprise architecture governance models

Drawing on the results from the study, the Council concludes by presenting a collection of best practices for governance models, processes and structures.

The presentation is used in the Purpose of this study to define the concept of a collaborative enterprise architecture governance program.

The presentation is part of the set of materials selected for coding during data analysis.

The source for this reference is from the *Best Practices Council for Architecture and IT Planning Executives* at Gartner Research. Members of the Council are senior executives in companies that generate over \$1 billion in revenue in North America and \$750 million in Europe. The purpose of the Council is as follows (Gartner Research, 2006):

“Identify best practices covering enterprise architecture and IT strategic planning. Members share lessons about aligning enterprise architecture with the organization's business strategy; effectively communicating the value proposition of enterprise architecture to key stakeholders; and preparing for change by focusing on corporate agility and innovation.”

The author of the presentation, Trish Jaffarian, is a vice president with Gartner Research.

Leganza, G. (2003). Project Governance and Enterprise Architecture Go Hand in Hand [Electronic Version]. Giga Planning Assumption.

This paper addresses the relationship between enterprise architecture governance and IT project governance. The paper “provides an overview of IT project governance methods and techniques prevalent in the industry and then relates the EA perspective to overall project governance goals” (Leganza, 2003, p. 1). Specific recommendations are also provided, such as implementing an architecture review board as a gating factor and implementing a consultative process for enterprise architecture governance.

The reference is used to support the organization for a sub-set of literature collected for this study, as defined in *Full Purpose* section. In addition, the paper is a key reference used to create one of the final outcome artifacts, a set of causal loop diagrams.

The paper is part of the set of materials selected for coding during data analysis.

Forrester Research, which acquired Giga Research in 2003, is a highly regarded independent technology and research company that serves over 2,000 companies. The company has been in the top 75 on Forbes' 200 Best Small Companies list for seven consecutive years (Forrester, 2007).

Malinverno, P. (2006). Service-Oriented Architecture Craves Governance (No. G00135396): Gartner Research.

In this paper, Malinverno defines the three major components associated with service-oriented architecture governance, and what results when governance is not applied to service-oriented architecture projects.

This paper is a key reference used to highlight the importance of service-oriented architecture governance, as explained in the *Significance of the Study* section. The paper is also a key reference used to create one of the final outcome artifacts, a set of causal loop diagrams.

The paper is part of the set of materials selected for coding during data analysis.

Paolo Malinverno, a Research VP with Gartner Research, covers application integration and middleware. He has authored and co-authored over 40 papers for Gartner, many of which are cited by other Gartner analysts.

Maranzano, J. F., Rozsypal, S. A., Zimmerman, G. H., Warnken, G. W., Wirth, P. E., & Weiss, D. M. (2005). Architecture Reviews: Practice and Experience. Software, IEEE, 22(2), 34-43.

This journal article describes a practical, stepwise approach to architecture reviews. The approach presented is based on the processes used at the companies where the four authors work (Millennium Services, Lucent Technologies, AT&T Labs, Avaya Labs).

The paper is used to support the definition for the term *architecture review*, and is also a key reference used to create one of the final outcome artifacts, the enterprise architecture governance conceptual model.

The paper is part of the set of materials selected for coding during data analysis.

The six authors of this paper are distinguished practitioners in the field of software engineering. Joseph Maranzano, a vice president of engineering at Millennium Services, is a member of the IEEE and a Bell Labs fellow. Sandra Rozsypal is retired from Lucent Technologies where she worked on financial and product management and was a member of its Systems Architecture Review Board. Guy Warnken leads the Technical Assessments Group of AT&T Global Networking Technology Services. Dr. David Weiss is the head of the Software

Technology Research Department at Avaya Labs. Dr. Weiss received his Ph.D. in computer science from the University of Maryland and is a senior member of the IEEE, a member of the ACM, and associate editor in chief of IEEE Transactions on Software Engineering. Dr. Patricia Wirth retired as the director of AT&T Labs' Network Design and Performance Analysis Department. Dr. Wirth received her D.Sc. in systems science and mathematics from Washington University in St. Louis. Dr. Wirth is also an AT&T fellow. Dr. Gus Zimmerman is the director of Lucent Technologies' Systems Architecture Review Board. Dr. Zimmerman,, who received his Ph.D. in physics from Harvard University, is a senior member of the IEEE and a member of the ACM and the American Society for Quality (ASQ).

The Open Group. (2005). Architecture Governance. Retrieved November 22, 2006 from http://www.opengroup.org/architecture/togaf8-doc/arch/chap26.html#tag_27_01.

This reference source is from a larger collection of materials on The Open Group Architecture Framework (TOGAF), which are available for download under license from the TOGAF information web site. In this chapter of the TOGAF guide, which pertains to architecture governance, the content pertaining to the conceptual structure for an architecture governance framework is particularly useful to this study. For this reason, the chapter is part of the set of materials selected for coding during data analysis.

Enterprise architecture practitioners and academics recognize TOGAF as one of the leading enterprise architecture frameworks in the IT industry, as evidenced by the number of citations in professional software engineering and enterprise architecture journals, textbooks, and conference proceedings. The Open Group has recently introduced a TOGAF certification program for enterprise architects to ensure that the framework is consistently used and applied.

Woolf, B. (2006). Introduction to SOA governance [Electronic Version]. Retrieved November 13, 2006 from <http://www-128.ibm.com/developerworks/library/ar-servgov/>.

This reference source provides an overview of service-oriented architecture governance. A collection of governance aspects is included, as well as reference hyperlinks to detailed documentation on specific governance practices.

This paper is a key reference used to define the term *service-oriented architecture governance*, as used in the Purpose and Problem Area sections in this study. The paper is also a key reference used to create one of the final outcome artifacts, a set of causal loop diagrams.

The paper is part of the set of materials selected for coding during data analysis.

This reference is included in IBM's developerWorks library of training resources. IBM's developerWorks Web site, which includes nearly 5.5 million registered users, has won 31 industry awards since its debut in 1999. Awards include Best Developer Web site, two consecutive Readers' Choice Awards from Software Development magazine ("Best Technical Support" provider), and five Jolt Product Excellence or Jolt Productivity Awards (IBM, 2006a).

Chapter III - Method

Literature review is the research approach used in this study (Leedy & Ormond, 2005). The purpose of a literature review is to draw on existing theories and prior research studies to identify a research problem and accompanying hypotheses and questions (Leedy & Ormond, 2005, p. 65). For this reason, literature review is well suited as a means to understand current published perspectives and ideas about enterprise architecture governance, which is evolving to meet the demands of service-oriented analysis, design and development.

Literature Collection

The first step in the data collection process is to search the World Wide Web (WWW) for published literature pertaining to enterprise architecture governance. The initial search targets include three academic databases (Academic Search Premier, Business Source Premier, Web of Science), two professional IT organizations (ACM Digital Library, IEEE Digital Library) and Google Scholar. Key search terms include *enterprise + architecture*, *architecture + governance*, and *enterprise + architecture + governance*. Preliminary search results, which number in the thousands for all keyword searches, indicate that the topic is worth studying.

A search strategy map created by the researcher is used to develop and conduct a refined search strategy. The revised search strategy leads to additional search keywords, an expanded list of target literature sources, and a restriction on the published date range. Some of the new keywords include *IT + governance*, *IT + project + governance*, *enterprise + architecture + frameworks*, *service-oriented + architecture*, and *service-oriented + architecture + governance*. Additional literature sources included in the revised search strategy include Web sites for additional professional organizations (The Open Group, World Wide Web Consortium, The

Organization for the Advancement of Structured Information Standards), university research departments (Carnegie Mellon), IT research companies (Gartner, Forrester), and software and professional services vendors (IBM, Rational Software, CIO Executive Board). To ensure that the published materials address the advances that have occurred in the enabling specifications, technologies and methods used in the analysis, design and development of service-oriented software systems, the revised search strategy is limited to materials published after 2002. As a result, approximately 80 sources are collected for use in this study.

Data Collection and Analysis

A sub-set of 19 sources is identified as the data set for content analysis. The eight-step conceptual analysis approach defined by Palmquist et al. (2006) is selected as the preferred data analysis approach. Specific objectives for the conceptual analysis process include the following:

- Identify the variety of ways concepts related to enterprise architecture are used in the literature.
- Identify the elements of enterprise architecture used to support an enterprise architecture governance program.
- Identify the interdependencies between enterprise architecture governance and service-oriented architecture governance, as concepts are described by Woolf (2006).

The first level of analysis is focused on identification of relevancy to words and word groups reflected in a sub-set of the list of the specific objectives described above. Words and word groups are developed through preliminary reading of the literature. This sub-set serves as the content basis for the initial pre-defined set of coding terms, which follows:

Concepts

- business strategies
- IT strategies
- IT governance
- IT project management

Elements

- enterprise architects
- architecture principles
- architecture frameworks
- architecture patterns
- architecture standards
- architecture tools

Interdependencies

- IT organization
- enterprise architecture organization
- architecture review board
- corporate culture
- IT culture
- system development methods
- architecture maturity
- governance objectives
- governance frameworks
- service-level agreements and operational-level agreements

- architecture reviews

During the data analysis process, the existence of concepts, elements and interdependencies, as well as the items themselves, is recorded.

When necessary, similar items are generalized and collapsed into single collective categories. Implication is permitted. For example, in this study the concept of *IT architecture* is assumed to mean *technology architecture*.

Translation rules are created to ensure that the coding rules are applied consistently throughout the data analysis process. For example, a translation rule specifies that when an instance of *IT architecture* is identified in the literature, it is recorded as the generalized concept *technology architecture*. The set of definitions established for the coding set in this study helps to frame the specific translation decisions, which guide the way in which instances are classified according to the three categories above (concepts, elements and interdependencies).

When the coding scheme is developed, irrelevant words such as *a*, *and*, *the* and so forth are ignored. However, since the field of enterprise architecture includes much technical jargon, the text in the literature that is not coded is re-examined manually to evaluate whether it is of value to the study.

The researcher then uses the following automated and manual methods to document the data analysis process:

- To facilitate coding and analysis, the researcher converts the sub-set of electronic resource items to Adobe's Portable Document Format (PDF), using the Mac OS X print dialog *Save as PDF* feature. Then, the sub-set of PDF files is stored in the Apple Mac OS X file folder *Capstone Data Analysis*.

- Using the Mac OS X Spotlight application, the researcher develops Smart Folders to organize the PDF files in the *Capstone Data Analysis* folder into logical subsets; each subset contains the PDF files from a Spotlight search for a particular word or word phrase. For example, the *ContentAnalysisSearch1.savedSearch* Smart Folder includes the sub-set of PDF files that contain the search terms *business strategy*, *business goal*, *strategic alignment*, *strategic objective*, and so forth.
- Within each Smart Folder, the researcher then uses the Search feature in the Adobe Acrobat Reader application to find the pre-defined words or word phrase instances. When an instance of the word or word phrase is found, the result (concept, element, interdependency) is recorded in one of three Microsoft Excel spreadsheet tables.
- Then, the researcher manually re-examines the literature and identifies additional terms, not previously coded, to include in the coding documentation. When a term is found, the researcher records the instance in one of the three Excel spreadsheet tables.

Data Presentation

Raw results from the data analysis coding process are collected and presented in the following three tables, one for each analysis objective (enterprise architecture concepts, elements and interdependencies). Table coding templates are demonstrated in Figures 1, 2 and 3.

Enterprise Architecture Concept	[Source No.] How Concept is Related to Enterprise Architecture
Business Strategies	
IT Strategies	
IT Governance	
IT Project Management	

Figure 1: Enterprise Architecture Concepts

Enterprise Architecture Element	[Source No.] How Enterprise Architecture Element Supports Governance
Enterprise Architects	
Architecture Principles	
Architecture Frameworks	
Architecture Patterns	
Architecture Standards	
Architecture Tools	

Figure 2: Enterprise Architecture Elements

Governance Component	[Source No.] Dependency Component has to Enterprise Architecture Governance or Service-Oriented Architecture Governance
IT Organization	
EA Organization	
Architecture Review Board	
Corporate Culture	
IT Culture	
System Development Methods	
Architecture Maturity	
Governance Objectives	
Governance Frameworks	
Service-Level & Operational-Level Agreements	
Architecture Reviews	

Figure 3: Cross Governance Interdependencies

Then, the results of the conceptual analysis process are analyzed again and presented in a final outcome study. The second level of analysis leads to the creation of the primary outcome of the study—a set of four artifacts that, when used together, provide a framework for a collaborative enterprise architecture governance program. The four artifacts include the following:

1. A template for a guide to enterprise architecture governance. This artifact, outlined in Figure 4, is intended as a guide for the chief enterprise architect to use when establishing or improving an organization's enterprise architecture governance program.

Part 1:	How to Use this Guide to Establish or Improve Your Organization's Enterprise Architecture Governance Program
Part 2:	Identifying Gaps in Your Organization's Enterprise Architecture Governance Organization, Processes and Tools
Part 3:	Identifying Variables and Interdependencies between Enterprise Architecture Governance and Service-Oriented Architecture Governance
Part 4:	Glossary of Enterprise Architecture Governance Terms

Figure 4: Template for Guide to Enterprise Architecture Governance

2. A conceptual model (see *Conclusion*) of an enterprise architecture governance program.
This model illustrates the relationships among the major elements in an enterprise architecture governance program. This model is intended for use by the chief architect to identify potential gaps in an organization's enterprise architecture governance program.
3. A set of causal loop diagrams (see *Conclusion*) that illustrate the dynamic relationships among some of the variables that influence enterprise architecture governance and service-oriented architecture governance. These diagrams are intended for use by the chief enterprise architect to identify some of the controllable variables in an organization's enterprise architecture governance program.
4. A preliminary glossary of terms (see *Conclusion*) pertaining to enterprise architecture governance. This artifact is used, in part, to identify how concepts related to enterprise architecture governance are used in the literature.

Chapter IV – Analysis of Data

Specific objectives for the conceptual analysis process in this study include the following:

- Identify the variety of ways concepts related to enterprise architecture are used in the literature, presented in a *Glossary of Enterprise Architecture Terms* (see *Conclusion*).
- Identify the elements of enterprise architecture used to support an enterprise architecture governance program.
- Identify the interdependencies between enterprise architecture governance and service-oriented architecture governance, as concepts are described by Woolf (2006).

The data set for content analysis is the set of 19 sources listed in *Appendix B*. Raw results from the first level of analysis are presented in appendices C, D and E. The coding search terms used during content analysis appear in column one of each table. The search terms include the pre-defined words and word phrases identified in the *Data Collection and Analysis* section of this study, along with the words and word phases found during content analysis. Search results found during content analysis are listed in column two of each table. Associated with each result item found is a number that corresponds to a source item listed in *Appendix B*.

Table 1 (see *Appendix C*) presents the data resulting from coding pertaining to enterprise architecture concepts, as they are presented in the selected literature. In this case, the term *Enterprise Architecture Concept* refers to a concept that has some bearing or relationship to enterprise architecture. The first column in Table 1 represents the concept (for example, a business strategy or an IT strategy) and the second column defines the concept, in relation to contextual usage in the specified source. The goal of this table is to report all the different ways that concepts pertaining to enterprise architecture are used and defined in the selected literature.

In total, four concepts are listed and defined, including *business strategy*, *IT strategy*, *IT governance*, and *IT project management*.

Several key observations are made from the data resulting from coding pertaining to enterprise architecture concepts: (1) The concept of *strategic alignment* is defined as the association between business strategy and IT strategy, and enterprise architecture is recognized as a supporting element. (2) In the selected literature, enterprise architecture is defined as one of the major decision areas related to IT governance, and the governance of enterprise architecture is seen to influence the behavior and practices of IT organizations. (3) Enterprise architecture effectiveness is tied to project governance.

Table 2 (see *Appendix D*) presents the data resulting from coding pertaining to enterprise architecture elements, as they are presented in the selected literature. In this case, the term *Enterprise Architecture Element* refers to the aspects of enterprise architecture that give it meaning and form, and serve to distinguish the field from other IT disciplines. The first column in Table 2 represents the element (for example, an enterprise architect or an architecture principle) and the second column defines how the element supports enterprise architecture governance. The goal of this table is to report all the different ways that enterprise architecture elements support enterprise architecture governance. In total, six enterprise architecture elements are listed, including *enterprise architect*, *architecture principle*, *architecture framework*, *architecture pattern*, *architecture standard*, and *architecture tool*.

The following key observations are made from the data resulting from coding pertaining to enterprise architecture elements: (1) Enterprise architects will increasingly assume more collaborative roles in organizations and on IT projects. (2) Enterprise architects need to understand the practices of *good enough* or *minimalist* architecture and recognize “what not to

architect” to support emergent systems and service-oriented systems. (3) Architecture patterns form a bridge between business architecture and technology architecture. (4) Interface standards and specialized tools are essential for the analysis, design, development and support of service-oriented systems.

Table 3 (see *Appendix E*) presents the data resulting from coding to determine the dependencies between enterprise architecture governance and service-oriented architecture governance, as they are presented in the selected literature. The first column in Table 3 refers to a component of enterprise architecture governance or service-oriented architecture governance. The second column defines the dependency the component has to enterprise architecture governance or service-oriented architecture governance. The goal of this table is to identify the common or shared components between enterprise architecture governance and service-oriented architecture governance. In total, 12 governance components are listed, including *IT organization, EA organization, architecture review board, corporate culture, IT culture, architecture maturity, system development method, governance objective, governance framework, service-level agreement, operational-level agreement, and architecture review*.

Examination of the data presented as the cross governance interdependencies yields the following key observations: (1) Enterprise-wide service-oriented architecture requires defined service owners with established governance responsibilities, as well as institutionalized governance policies and models. (2) A model for the new enterprise architecture organization requires multi-disciplined architects who can take strategic requirements to resolution. (3) An architecture review board and an architecture review process are essential components required for enterprise architecture governance. (4) An organization’s corporate culture and IT culture can shape enterprise architecture governance, as well as service-oriented architecture governance. (5)

Contemporary system development methods require new approaches to architecture governance, based on service-level agreements.

Chapter V – Conclusions

The primary outcome of this study is a set of four artifacts that, when used together, provide a framework for the chief enterprise architect to use to develop a collaborative enterprise architecture governance program for his/her organization. Each of these artifacts is integrated into the final outcome of this study, titled a *Guide to Enterprise Architecture Governance*. The Guide is presented below in four parts, including: (1) an introduction that explains how the Guide is best used by the chief enterprise architect to either establish or improve an organization's enterprise architecture governance program, (2) a strategy to be used to identify potential gaps in an organization's enterprise architecture governance program (presented as a conceptual model), (3) a strategy to identify some of the controllable variables related to enterprise architecture governance and service-oriented architecture governance (presented as a set of causal loop diagrams), and (4) a glossary of enterprise architecture governance terms.

Guide to Enterprise Architecture Governance

Part 1: How to Use this Guide to Establish or Improve Your Organization's Enterprise Architecture Governance Program

If your organization currently has an enterprise architecture governance program in place, the *Guide to Enterprise Architecture Governance* can be used to identify key missing components, as well as opportunities for improvement. If your organization does not currently have an enterprise architecture governance program, the Guide can be used, along with additional reference sources cited in this study, to help you begin program-planning activities.

Part 2: Identifying Gaps in Your Organization's Enterprise Architecture Governance Organization, Processes and Tools

Figure 5 (see below) presents a conceptual model of an enterprise architecture governance program, based on the results from this study. The model depicts the major elements in an enterprise architecture governance program, as well as the significant relationships among the elements. The model can be used to help you identify potential gaps in your organization's enterprise architecture governance organization, processes and tools.

Enterprise Architecture Governance Program Conceptual Model

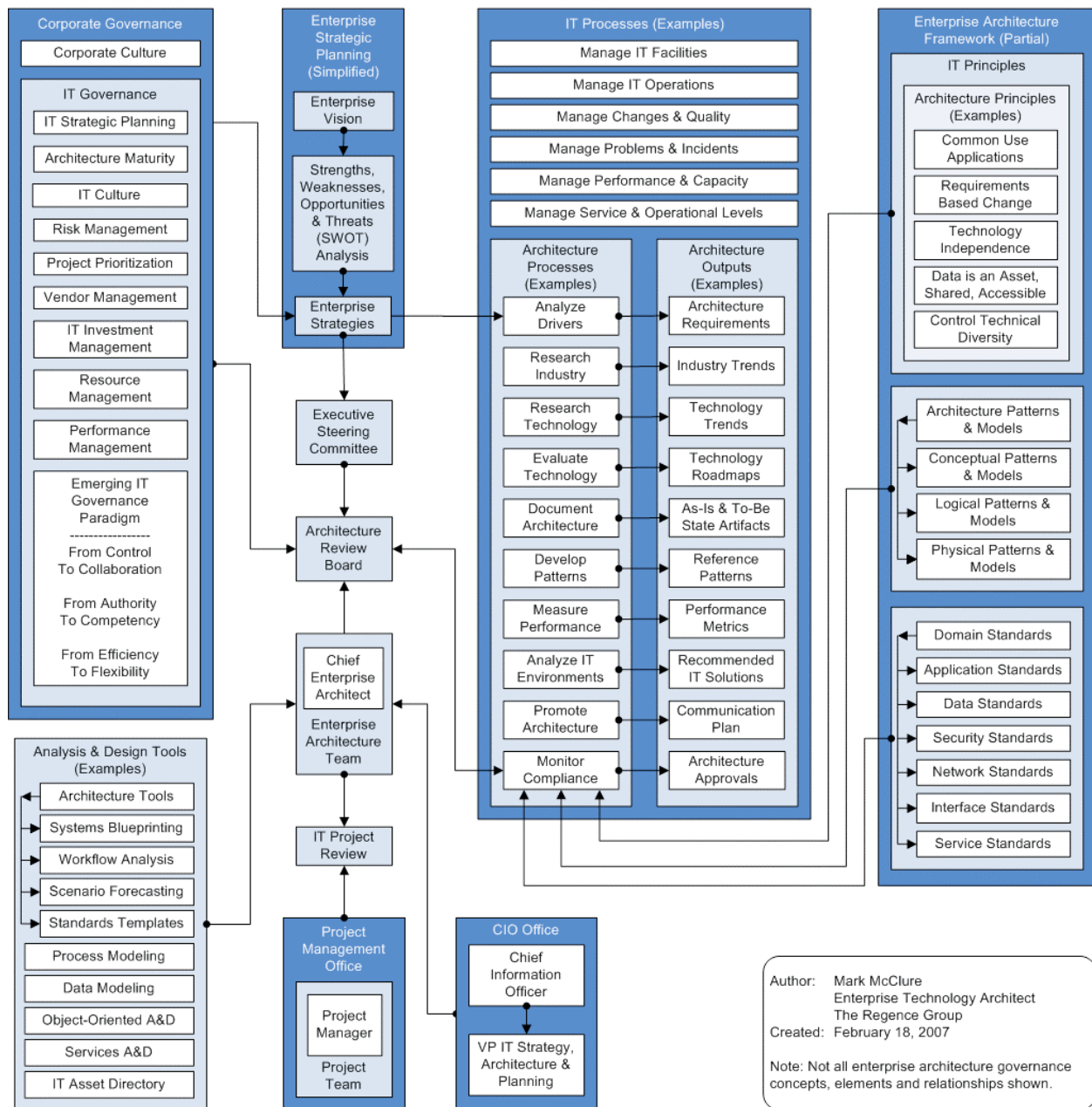


Figure 5. Enterprise Architecture Governance Conceptual Model

Part 3: Identifying Variables and Interdependencies between Enterprise Architecture Governance and Service-Oriented Architecture Governance

Based on the results from this study, Figure 6 (see below) presents a set of causal loop diagrams that illustrate the dynamic relationships among some of the variables that influence enterprise architecture governance and service-oriented architecture governance. The causal loop diagrams can be used to help you identify some of the controllable variables in your enterprise architecture governance program.

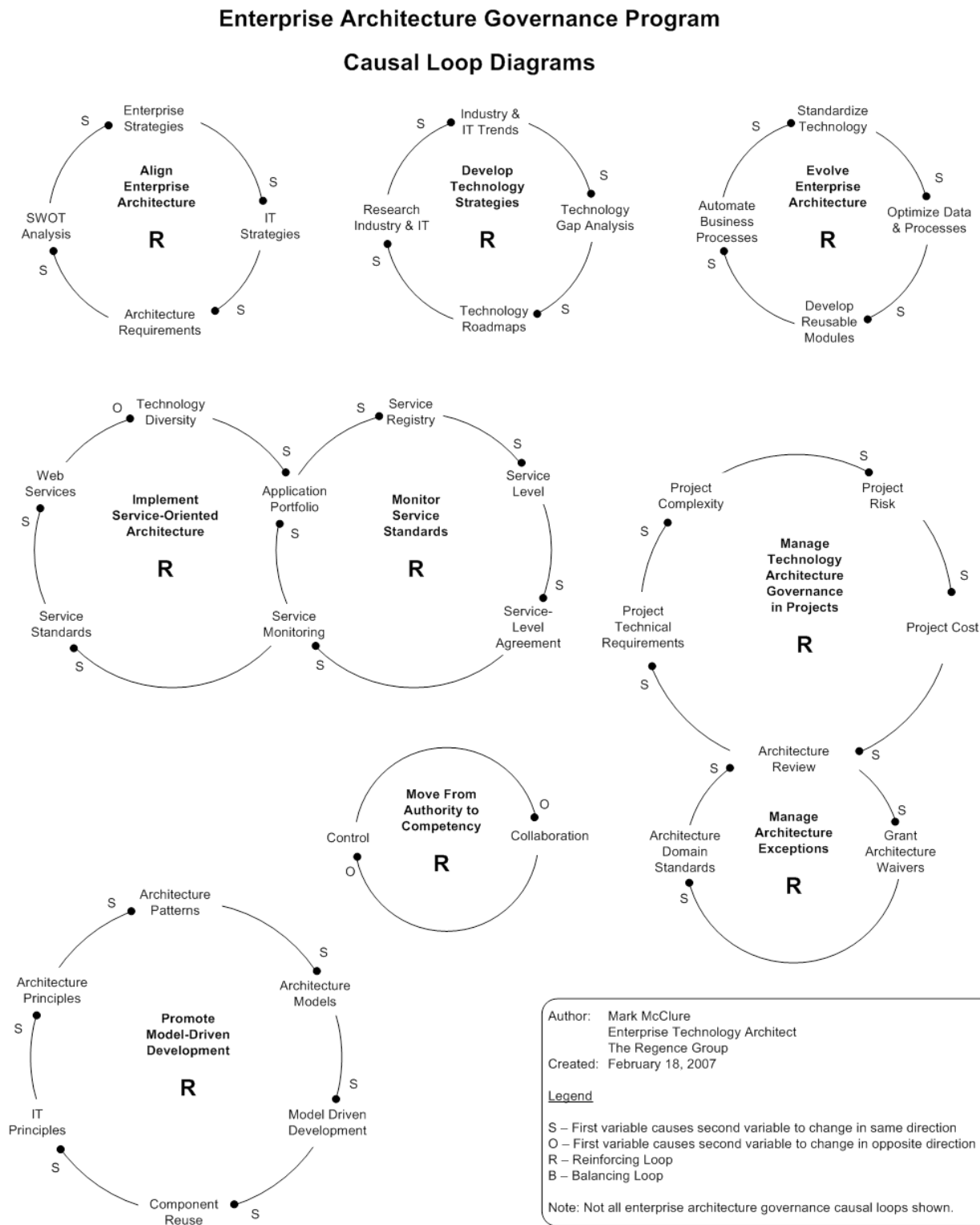


Figure 6. Enterprise Architecture Governance Causal Loop Diagrams

Part 4: Glossary of Enterprise Architecture Governance Terms

This glossary (see below) presents terminology pertaining to enterprise architecture governance. The glossary is used, in part, to help you identify how concepts related to enterprise architecture governance are used in the literature.

Glossary of Enterprise Architecture Governance Terms

Architecture principle: "Architecture principles are a subset of IT principles that relate to architecture work. They reflect a level of consensus across the enterprise, and embody the spirit and thinking of the enterprise architecture" (The Open Group, 2006d).

Architecture maturity As defined by Ross, Weill and Robertson (Ross et al., 2006, p. 71), the four stages of architecture maturity are (1) Business Silos architecture, (2) Standardized Technology architecture, (3) Optimized Core architecture, and (4) Business Modularity architecture.

Architecture review (architecture compliance review): "An Architecture Compliance review is a scrutiny of the compliance of a specific project against established architectural criteria, spirit, and business objectives. A formal process for such reviews normally forms the core of an enterprise Architecture Compliance strategy" (The Open Group, 2006d).

Architecture review board (architecture board): "A key element in a successful architecture governance strategy (see Architecture Governance) is a cross-organization Architecture Board to oversee the implementation of the strategy. This body should be representative of all the key stakeholders in the architecture, and will typically comprise a group of executives responsible for the review and maintenance of the overall architecture" (The Open Group, 2006a).

Chief enterprise architect: "The chief enterprise architect (also known as the "chief architect" or simply the "enterprise architect") is responsible for leading the program to develop, maintain, govern and evolve the enterprise architecture across the enterprise. The chief enterprise architect is also responsible for defining the enterprise architecture process and the architecture review process, as well as for leading the effective integration of these processes with other, related business and IT processes" (Handler & Weiss, 2006, p. 3).

Enterprise architecture: "Enterprise architecture is the process of translating business vision and strategy into effective enterprise change by creating, communicating and improving the key principles and models that describe the enterprise's future state and enable its evolution" (Lapkin, 2006, p. 9).

Enterprise architecture framework (architecture framework): "An architecture framework is a tool which can be used for developing a broad range of different architectures. It should

describe a method for designing an information system in terms of a set of building blocks, and for showing how the building blocks fit together. It should contain a set of tools and provide a common vocabulary. It should also include a list of recommended standards and compliant products that can be used to implement the building blocks” (The Open Group, 2006j).

Enterprise architecture model (architecture model): An architecture model is used as a means to capture the complex, multi-layered and cross-domain details associated with enterprise architecture. Modeling "provides architects and others with the ability to visualize entire systems, assess different options and communicate designs more clearly before taking on the risks-technical, financial, or otherwise-of actual construction" (Cernosek & Naiburg, 2004, p. 2).

Enterprise architecture pattern: "From an enterprise architecture standpoint, we can describe a pattern as being a practical and logical construct that shows the interaction of key logical elements of functionality and the relationships of these components to carry out core elements of system design. Patterns fit into an architecture framework as an intermediate stage of the architecture process, taking an understanding of business architecture and business process, and showing logical arrangements of technology in support of the business architecture” (Schulman, 2004, p. 2).

Enterprise architecture standard: Enterprise architecture standards cover a wide range of subject and technology domain areas; e.g., architecture representation (The Open Group, 2006c), business rules and process management (The Open Group, 2006f), modeling and metadata specifications (The Open Group, 2006h), enterprise engineering and integration (CIMOSA Association, 2006), and so forth.

Enterprise architecture tool: James (2005, p. 1) states an enterprise architecture tool has:

- A repository in which to store information about the business, applications, data and technologies
- A metamodel to structure this information
- The ability to represent information in the repository in graphical and textual forms

Governance: Governance “is essentially about ensuring that business is conducted properly. It is less about overt control and strict adherence to rules, and more about guidance and effective and equitable usage of resources to ensure sustainability of an organization's strategic objectives” (The Open Group, 2005).

Reference Model: "A reference model is an abstract framework for understanding significant relationships among the entities of some environment that enables the development of specific architectures using consistent standards or specifications supporting that environment. A reference model consists of a minimal set of unifying concepts, axioms and relationships within a particular problem domain, and is independent of specific standards, technologies, implementations, or other concrete details” (Organization for the Advancement of Structured Information Standards, 2006b, p. 29).

Appendix A – Definitions of Terms

Application architecture: “Establishes patterns, guidelines and templates for building and integrating applications according to the major delivery channels and quality of service characteristics that constitute a given enterprise’s range of application profiles” (Heffner, 2002, p. 4).

Architecture: Just as the term *architecture* does not have a clear meaning in building architecture (Jonkers et al., 2006, p. 1), the same is true in information technology (IT). Since the advent of electronic computing, the term *architecture* has had various meanings depending on its context of use. For example, in the case of computing hardware, *architecture* describes the construction *blueprint* of a device or component. When used in the context of information systems, however, *architecture* is used as an abstraction to deal with complexity (Iyer & Gottlieb, 2004, p. 587).

Architecture maturity: As defined by Ross, Weill and Robertson (Ross et al., 2006, p. 71), the four stages of architecture maturity are:

1. Business Silos architecture: where companies look to maximize individual business unit needs or function needs.
2. Standardized Technology architecture: providing IT efficiencies through technology standardization and, in most cases, increased centralization of technology management.
3. Optimized Core architecture: which provides companywide data and process standardization as appropriate for the operating model.

4. Business Modularity architecture: where companies manage and reuse loosely coupled IT-enabled business process components to preserve global standards while enabling local differences.

Architecture principle: As defined by The Open Group (2006e), “Principles are general rules and guidelines, intended to be enduring and seldom amended, that inform and support the way in which an organization sets about fulfilling its mission.

In their turn, principles may be just one element in a structured set of ideas that collectively define and guide the organization, from values through to actions and results.

Depending on the organization, principles may be established at any or all of three levels:

- Enterprise principles provide a basis for decision-making throughout an enterprise, and inform how the organization sets about fulfilling its mission. Such enterprise-level principles are commonly found in governmental and not-for-profit organizations, but are encountered in commercial organizations also, as a means of harmonizing decision-making across a distributed organization. In particular, they are a key element in a successful architecture governance strategy (see Architecture Governance).
- Information Technology (IT) principles provide guidance on the use and deployment of all IT resources and assets across the enterprise. They are developed in order to make the information environment as productive and cost-effective as possible.
- Architecture principles are a subset of IT principles that relate to architecture work. They reflect a level of consensus across the enterprise, and embody the spirit and thinking of the enterprise architecture. Architecture principles can be further divided into:

- Principles that govern the architecture process, affecting the development, maintenance, and use of the enterprise architecture
- Principles that govern the implementation of the architecture, establishing the first tenets and related guidance for designing and developing information systems

Architecture review: The purpose of an architecture review, as defined in the Rational Unified Process (IBM, 2006b), is to address the following:

- To uncover any unknown or perceived risks in the schedule or budget.
- To detect any architectural design flaws. Architectural flaws are known to be the hardest to fix, the most damaging in the long run.
- To detect a potential mismatch between the requirements and the architecture: over-design, unrealistic requirements, or missing requirements. In particular the assessment may examine some aspects often neglected in the areas of operation, administration and maintenance. How is the system installed? How do we transition the current databases?
- To evaluate one or more specific architectural qualities: performance, reliability, modifiability, security, safety
- To identify reuse opportunities

The Open Group (2006b) states that “An Architecture Compliance review is a scrutiny of the compliance of a specific project against established architectural criteria, spirit, and business objectives. A formal process for such reviews normally forms the core of an enterprise Architecture Compliance strategy.” The Open Group describes the generic goals of an Architecture Compliance review to include some or all of the following:

- First and foremost, catch errors in the project architecture early, and thereby reduce the cost and risk of changes required later in the lifecycle. This in turn means that the overall project time is shortened, and that the business gets the bottom-line benefit of the architecture development faster.
- Ensure the application of best practices to architecture work.
- Provide an overview of the compliance of an architecture to mandated enterprise standards.
- Identify where the standards themselves may require modification.
- Identify services that are currently application-specific but might be provided as part of the enterprise infrastructure.
- Document strategies for collaboration, resource sharing, and other synergies across multiple architecture teams.
- Take advantage of advances in technology.
- Communicate to management the status of technical readiness of the project.
- Identify key criteria for procurement activities (e.g., for inclusion in Commercial Off-The-Shelf (COTS) product RFI/RFP documents).
- Identify and communicate significant architectural gaps to product and service providers.

In the 2005 IEEE Computer Society report titled *Architecture Reviews: Practice and Experience*, architecture reviews are cited as valuable for the following reasons (Maranzano et al.):

- Find design problems early in development when they are less expensive to fix
- Leverage experienced people by using their expertise and experience to help other projects in the company

- Let the companies better manage software components suppliers
- Provide management with better visibility into technical and project management issues
- Generate good problem descriptions by having the review team critique them for consistency and completeness
- Rapidly identify knowledge gaps and establish training in areas where errors frequently occur (for example, creating a companywide performance course when many reviews indicated performance issues)
- Promote cross-product knowledge and learning
- Keep experts engaged
- Spread knowledge of proven practices in the company by using the review teams to capture these practices across projects

Business architecture: “We use the concept of ‘Business Architecture’ to structure the responsibility over business activities prior to any further effort to structure individual aspects (processes, data, functions, organization, etc.). The business architecture arranges the responsibilities around the most important business activities (for instance production, distribution, marketing, et cetera) and/or economic activities (for instance manufacturing, assembly, transport, wholesale, et cetera) into domains” (Versteeg & Bouwman, 2006, p. 92).

Business strategy: “A strategy defines a framework for guiding the choice of actions. It is a broad articulation of the kinds of products the organization will product, the basis on which its products will compete with those of its competitors, and the types of resources and capability the

firm must have or develop to implement the strategy successfully” (Saloner, Shepard, & Podolny, 2001, p. 4).

Causal Loop Diagram (CLD): “Causal loop diagrams (CLDs) are a kind of systems thinking tool. These diagrams consist of arrows connecting variables (things that change over time) in a way that shows how one variable affects another” (Pegasus Communications, 2006a).

CLDs contain several components (Anderson & Johnson, 1997, p. 52):

- One of more feedback loops that are either reinforcing or balancing processes
- Cause-and-effect relationships among the variables
- Delays

Chief enterprise architect: “The chief enterprise architect (also known as the "chief architect" or simply the "enterprise architect") is responsible for leading the program to develop, maintain, govern and evolve the enterprise architecture across the enterprise. The chief enterprise architect is also responsible for defining the enterprise architecture process and the architecture review process, as well as for leading the effective integration of these processes with other, related business and IT processes” (Handler & Weiss, 2006, p. 3).

“The responsibilities for this role vary by organization, but generally include the following: (Handler & Weiss, 2006, pp. 3-4).

- Leading the creation or evolution of the enterprise architecture function/program, including the coordination of an appropriately balanced pursuit of enterprise business, information, technical and solution architectures

- Understanding, advocating and supporting the enterprise's information technology (IT) strategies
- Leading the identification and analysis of enterprise business drivers to derive enterprise business, information, technical and solution architecture requirements
- Analyzing the current IT environment to detect critical deficiencies and recommend solutions for improvement
- Analyzing technology industry and market trends as well as determining their potential impact on the enterprise
- Promoting the enterprise architecture process, outcomes and results to the organization, including the enterprise's IT and business leaders
- Leading and facilitating the creation of governing principles to guide information, technology and solution decision making for the enterprise
- Leading the development of an implementation plan for the enterprise architecture based on business requirements and IT strategies
- Ensuring that the optimal governance structure and compliance activities (such as handling waivers) are associated with enterprise architecture compliance
- Overseeing enterprise architecture implementation and ongoing refinement activities
- Overseeing the evaluation and selection of hardware and software product standards, as well as the design of standard configurations
- Consulting with application development project teams to fit systems to architecture, as well as to identify when it is necessary to modify the technical architecture to accommodate project needs

- Consulting with infrastructure development projects to fit infrastructure to architecture, as well as to identify when it is necessary to modify the technical architecture to accommodate infrastructure needs
- Identifying organizational requirements for the resources, structures and cultural changes necessary to support the enterprise architecture
- Overseeing the documentation of all architecture design and analysis work
- Leading the development and execution of a communication and education plan for the enterprise architecture
- Assessing (through appropriate metrics) and communicating the achievement and impact of the enterprise architecture”

Commercial-Off-The-Shelf (COTS): “The term COTS (Commercial-Off-The-Shelf) products can, in principle, apply to any component that is offered by a third-party vendor. However, it is more normally used to refer to system software products” (Sommerville, 2001, p. 315).

Conceptual model: “Using visual methods to communicate ideas entails creating a sub-structure of non-verbal communication. Too often do designers make hasty, unrefined drawings that must be laboriously over-explained to colleagues and clients. The very premise of visualization is that a conceptual model is created to convey thinking, or “tell a story” to someone else” (Baskinger & Nam, 2006, p. 1).

Data architecture: “Ranges from strategic views of data used for executive reporting and business planning, through data warehousing, business intelligence and operational data for

transactional applications. Its scope includes both data design and the principles and policies that govern its ownership, use, and management across the enterprise” (Heffner, 2002, p. 5).

Enterprise application blueprinting: “To achieve their objective of aligning IT and business strategies, EA groups focus scarce central group resources on three highly-leveraged activities—creating the IT strategic plan and overseeing the investment prioritization process, blueprinting the enterprise application environment, and prioritizing retirement candidates (Enterprise Architecture Executive Council, 2005, p. 27).

Enterprise architecture: “Enterprise architecture is the process of translating business vision and strategy into effective enterprise change by creating, communicating and improving the key principles and models that describe the enterprise's future state and enable its evolution” (Lapkin, 2006, p. 9). The term *enterprise* in this case means “a collection of organizations that share a common set of goals and objectives” (p. 3). Enterprise architecture is also seen to encompass ‘domain architectures’ such as business process architecture, data architecture, applications architecture and technology architecture (Ross et al., 2006, p. 48).

Enterprise architecture concept: “When the architecture for a new building is captured in blueprints, enterprise architecture is often represented in principles, policies, and technology choices. Thus, the concept can be difficult for managers to get their arms around. We have found that a simple picture, which we refer to as the “core diagram,” helps managers debate and eventually come to understand their company’s enterprise architecture. This simple one-page

picture is a high-level view of the processes, data, and technologies constituting the desired foundation for execution” (Ross et al., 2006, p. 50)

Enterprise architecture framework: As defined by The Open Group, “An architecture framework is a tool which can be used for developing a broad range of different architectures. It should describe a method for designing an information system in terms of a set of building blocks, and for showing how the building blocks fit together. It should contain a set of tools and provide a common vocabulary. It should also include a list of recommended standards and compliant products that can be used to implement the building blocks (The Open Group, 2006j).

Martin and Robertson (2003, p. 562) state that an enterprise architecture framework is used as a means to organize and present architecture models, and that two distinct model management approaches include: (1) managing models according to the perspectives of model users, and (2) using a life-cycle approach as an organizing theme.

Enterprise architecture development method: As a representative example, the Architecture Development Method (ADM) from The Open Group is “a method for developing an enterprise architecture” (2006g). The ADM provides (Blevins, Spencer, & Waskiewicz):

- A reliable, proven way of developing the architecture
- Architecture views which enable the architect to ensure that a complex set of requirements are adequately addressed
- Linkages to practical case studies
- Guidelines on tools for architecture development

Enterprise architecture model: An architecture model is used as a means to capture the complex, multi-layered and cross-domain details associated with enterprise architecture.

Modeling “provides architects and others with the ability to visualize entire systems, assess different options and communicate designs more clearly before taking on the risks—technical, financial, or otherwise—of actual construction” (Cernosek & Naiburg, 2004, p. 2).

Enterprise architecture pattern: “From an enterprise architecture standpoint, we can describe a pattern as being a practical and logical construct that shows the interaction of key logical elements of functionality and the relationships of these components to carry out core elements of system design. Patterns fit into an architecture framework as an intermediate stage of the architecture process, taking an understanding of business architecture and business process, and showing logical arrangements of technology in support of the business architecture” (Schulman, 2004, p. 2).

Enterprise architecture process: Enterprise architecture processes span many activities. In a study of 24 large corporations, the Enterprise Architecture Executive Council (2005) identified the following top five activities performed by enterprise architecture groups:

1. IT strategic planning and investment prioritization
2. Enterprise application blueprinting
3. Application portfolio management
4. Development language, platform, and tool selection
5. Enterprise data modeling and reference data management

Enterprise architecture standard: Enterprise architecture standards cover a wide range of subject and technology domain areas; e.g., architecture representation (The Open Group, 2006c), business rules and process management (The Open Group, 2006f), modeling and metadata specifications (The Open Group, 2006h), enterprise engineering and integration (CIMOSA Association, 2006), and so forth.

Enterprise architecture tool: “Enterprise architecture tools typically offer the following key functionalities (Corporate Executive Board, 2006, p. 1):

- Business process definition
- Business architecture design
- IT architecture design
- Systems mapping
- Workflow design
- Process analysis
- Data modeling
- Simulation
- Reporting and publishing
- Framework templates
- Standards templates
- Compliance templates”

Extensible Markup Language (XML): “Extensible Markup Language, abbreviated XML, describes a class of data objects called XML documents and partially describes the behavior of

computer programs which process them. XML is an application profile or restricted form of SGML, the Standard Generalized Markup Language [ISO 8879]” (World Wide Web Consortium, 2006c).

Governance: As used in this study, governance “is essentially about ensuring that business is conducted properly. It is less about overt control and strict adherence to rules, and more about guidance and effective and equitable usage of resources to ensure sustainability of an organization's strategic objectives” (The Open Group, 2005). Within the context of information technology (IT) and as used in this study, governance is “the assignment of decision-making rights and accountabilities regarding behavior in the desirable use of IT” (Dreyfuss, 2003, p. 2).

In the hierarchy of governance structures, IT governance encompasses architecture governance, which is “the practice and orientation by which enterprise architectures and other architectures are managed and controlled at an enterprise-wide level” (The Open Group, 2005).

Interdependency (between Enterprise Architecture Governance and Service-Oriented Architecture Governance): “Any implementation of governance should be centered on the four pillars of an enterprise architecture: people, processes, technology, and services. One mechanism to implement an enterprise IT and SOA governance is by establishing a center of excellence (CoE) for IT and SOA governance that would enable a shared resource and capability center to function as a resource pool as new business application needs arise” (Mitra, 2005).

“There is a common misconception that SOA governance is governance of an SOA, as though SOA were one more IT asset in need of governance in the organization. That belief, however, indicates a fundamental misunderstanding of the role of SOA. Fundamentally, SOA is

enterprise architecture—when an enterprise adopts SOA, it should approach the organization of all of its IT assets from an SO perspective. As such, Service orientation provides a broad organizing principle for all aspects of IT in the company—including IT governance. That's why we say SOA governance is IT governance in the context of SOA, rather than governance of SOA” (Bloomberg, 2004).

“SOA governance is a social change. The enterprise architect plays the role of the teacher or educator, not the policeman. The policing can be performed by the review board. Your role as the mentor to the application teams is to show them the value of governance; how they can benefit from the governance processes, policies, and tools in place; and how the additional work involved in following these policies can help them be more productive and deliver more business value” (Mittal, 2006).

International Organization for Standardization (ISO): “ISO is a network of the national standards institutes of 157 countries, on the basis of one member per country, with a Central Secretariat in Geneva, Switzerland, that coordinates the system” (International Organization for Standardization, 2006).

Model-Driven Architecture (MDA): The Object Management Group’s “Model-Driven Architecture starts with the well-known and long established idea of separating the specification of the operation of a system from the details of the way that system uses the capabilities of its platform. MDA provides an approach for, and enables tools to be provided for:

- specifying a system independently of the platform that supports it,
- specifying platforms,

- choosing a particular platform for the system, and
- transforming the system specification into one for a particular platform.

The three primary goals of MDA are portability, interoperability and reusability through architectural separation of concerns” (Miller & Mukerji, pp. 2-2).

Object Management Group (OMG): The OMG is an international, open membership, not-for-profit computer industry consortium that was formed in 1989. “OMG’s modeling standards, including the Unified Modeling Language™ (UML®) and Model Driven Architecture® (MDA®), enable powerful visual design, execution and maintenance of software and other processes, including IT Systems Modeling and Business Process Management. OMG’s middleware standards and profiles are based on the Common Object Request Broker Architecture (CORBA®) and support a wide variety of industries” (Object Management Group, 2006).

Organization for the Advancement of Structured Information Standards (OASIS): “OASIS (Organization for the Advancement of Structured Information Standards) is a not-for-profit, international consortium that drives the development, convergence, and adoption of e-business standards. The consortium produces more Web services standards than any other organization along with standards for security, e-business, and standardization efforts in the public sector and for application-specific markets. Founded in 1993, OASIS has more than 5,000 participants representing over 600 organizations and individual members in 100 countries” (Organization for the Advancement of Structured Information Standards, 2006a).

Portable Operating System Interface (POSIX): “POSIX is a registered trademark of the IEEE.

POSIX is an acronym for Portable Operating System Interface. Although originated to refer to the original IEEE Std 1003.1-1988, the name POSIX more correctly refers to a family of related standards: IEEE Std 1003.n (where n is a number) and the parts of ISO/IEC 9945. The term POSIX was originally used as a synonym for IEEE Std 1003.1-1988. A preferred term for that standard, POSIX.1, emerged. This maintained the advantages of readability of the symbol “POSIX” without being ambiguous with the POSIX family of standards” (The Open Group, 2006i).

Program and portfolio management (PPM): “PPM is a set of activities that govern how organizations select and manage a group of specific investment initiatives to achieve defined business results or affect change” (Apfel, 2006, p. 1).

Project governance: Five primary goals that are common motivations for creating project governance structures and processes include the following: (Leganza, 2003, p. 2)

1. controlling cost
2. ensuring business value
3. maximizing resources
4. providing a balanced investment portfolio
5. ensuring the uniform application of best practices

Reference Model: “A reference model is an abstract framework for understanding significant relationships among the entities of some environment that enables the development of specific

architectures using consistent standards or specifications supporting that environment. A reference model consists of a minimal set of unifying concepts, axioms and relationships within a particular problem domain, and is independent of specific standards, technologies, implementations, or other concrete details” (Organization for the Advancement of Structured Information Standards, 2006b, p. 29).

Resource Definition Framework (RDF): “The Resource Description Framework (RDF) is a language for representing information about resources in the World Wide Web. It is particularly intended for representing metadata about Web resources, such as the title, author, and modification date of a Web page, copyright and licensing information about a Web document, or the availability schedule for some shared resource” (World Wide Web Consortium, 2004).

Service-Oriented Architecture (SOA): “Service Oriented Architecture is a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. It provides a uniform means to offer, discover, interact with and use capabilities to produce desired effects consistent with measurable preconditions and expectations” (Organization for the Advancement of Structured Information Standards, 2006b, p. 29).

Simple Object Access Protocol (SOAP): “SOAP Version 1.2 (SOAP) is a lightweight protocol intended for exchanging structured information in a decentralized, distributed environment. It uses XML technologies to define an extensible messaging framework providing a message construct that can be exchanged over a variety of underlying protocols. The framework has been

designed to be independent of any particular programming model and other implementation specific semantics” (World Wide Web Consortium, 2003).

Software as a Service (SaaS): “Software owned, delivered and managed remotely by one or more providers. If the vendor requires user organizations to install software on-premise using their infrastructures, then it isn't SaaS. SaaS delivery requires a vendor to provide remote, outsourced access to the application, as well as maintenance and upgrade services for it. The infrastructure and IT operations supporting the applications must also be outsourced to the vendor or another provider” (Clark, Desisto, Holincheck, White, & Kyte, 2006, p. 4).

System development methodology: Sommerville (2001, pp. 44-55) defines the following four general process models as abstractions to explain different approaches to software development:

1. Waterfall model
2. Evolutionary development
3. Formal systems development
4. Reuse-based development

Systems thinking: “Systems thinking offers you a powerful new perspective, a specialized language, and a set of tools that you can use to address the most stubborn problems in your everyday life and work. Systems thinking is a way of understanding reality that emphasizes the relationships among a system's parts, rather than the parts themselves. Based on a field of study known as system dynamics, systems thinking has a practical value that rests on a solid theoretical foundation” (Pegasus Communications, 2006b).

In general, systems thinking is characterized by these principles (Anderson & Johnson, 1997, p. 18):

- thinking of the “big picture”
- balancing short-term and long-term perspectives
- recognizing the dynamic, complex, and interdependent nature of systems
- taking into account both measurable and non-measurable factors
- remembering that we are all part of the systems in which we function, and that we each influence those systems even as we are being influenced by them.

Technical Architecture: “Captures decisions on technology required to support general infrastructure requirements (e.g., e-mail, file sharing, desktop computing) as well as hardware and software infrastructure for enterprise data and applications (e.g., DBMS, servers, networks, application server software, data warehousing, etc.)” (Heffner, 2002, p. 5).

The Open Group Architecture Framework (TOGAF): “The original development of TOGAF Version 1 in 1995 was based on the Technical Architecture Framework for Information Management (TAFIM), developed by the US Department of Defense (DoD). The DoD gave The Open Group explicit permission and encouragement to create TOGAF by building on the TAFIM, which itself was the result of many years of development effort and many millions of dollars of US Government investment” (The Open Group, 2006j).

“TOGAF in its Enterprise Edition remains what it has always been, namely an architecture framework - a set of methods and tools for developing a broad range of different IT architectures. It enables IT users to design, evaluate, and build the right architecture for their

organization, and reduces the costs of planning, designing, and implementing architectures based on open systems solutions” (The Open Group, 2006k)

Web Services Description Language (WSDL): “Web Services Description Language Version 2.0 (WSDL 2.0) provides a model and an XML format for describing Web services. WSDL 2.0 enables one to separate the description of the abstract functionality offered by a service from concrete details of a service description such as “how” and “where” that functionality is offered” (Chinnici, Gudgin, Moreau, Schlimmer, & Weerawarana, 2004, p. 8).

World Wide Web Consortium (W3C): “The World Wide Web Consortium (W3C) is an international consortium where Member organizations, a full-time staff, and the public work together to develop Web standards. W3C's mission is: To lead the World Wide Web to its full potential by developing protocols and guidelines that ensure long-term growth for the Web” (World Wide Web Consortium, 2006a).

Zachman Framework for Enterprise Architecture: “The Framework as it applies to Enterprises is simply a logical structure for classifying and organizing the descriptive representations of an Enterprise that are significant to the management of the Enterprise as well as to the development of the Enterprise’s systems. It was derived from analogous structures that are found in the older disciplines of Architecture/Construction and Engineering/Manufacturing that classify and organize the design artifacts created over the process of designing and producing complex physical products (e.g., buildings or airplanes)” (Zachman, 1996, p. 1).

Appendix B – Data Set for Content Analysis

1. Bieberstein, N., Bose, S., Walker, L., & Lynch, A. (2005). Impact of service-oriented architecture on enterprise systems, organizational structures, and individuals. *IBM Systems Journal*, 44(4), 691-708.
2. Boehm, B. (2006). A view of 20th and 21st century software engineering. Paper presented at the Proceeding of the 28th international conference on Software engineering.
3. Burke, B. (2006). Implement an Effective Assurance Process for Your Enterprise Architecture (No. G00141577): Gartner Research.
4. Burke, B. (2006). What Not to Architect (No. G00141840): Gartner Research.
5. Enterprise Architecture Executive Council. (2006). Key Developments in Enterprise Architecture, 2006 Briefing for Chief Information Officers [Electronic Version]. Retrieved December 10, 2006.
6. Gerrard, M. (2006). Defining IT Governance: The Gartner IT Governance Demand/Supply Model (No. G00140091): Gartner Research.
7. Greenfield, J., & Short, K. (2003). Software factories: assembling applications with patterns, models, frameworks and tools: ACM Press New York, NY, USA.
8. Handler, R., & Weiss, D. (2006). Role Definition and Organization Structure: Chief Enterprise Architect (No. G00138141): Gartner Research.
9. Jaffarian, T. (2005). Enterprise Architecture Governance: Gartner Research.
10. Lapkin, A. (2004). A User's Guide to Architecture Patterns (No. G00124049): Gartner Research.
11. Leganza, G. (2003). Project Governance and Enterprise Architecture Go Hand in Hand [Electronic Version]. Giga Planning Assumption.
12. Lindström, Å., Johnson, P., Johansson, E., Ekstedt, M., & Simonsson, M. (2006). A survey on CIO concerns-do enterprise architecture frameworks support them? *Information Systems Frontiers*, 8(2), 81-90.
13. Malinverno, P. (2006). Service-Oriented Architecture Craves Governance (No. G00135396): Gartner Research.
14. Maranzano, J. F., Rozsypal, S. A., Zimmerman, G. H., Warnken, G. W., Wirth, P. E., & Weiss, D. M. (2005). Architecture Reviews: Practice and Experience. *Software, IEEE*, 22(2), 34-43.
15. Ross, J. W., Weill, P., & Robertson, D. C. (2006). Enterprise Architecture as Strategy: Creating a Foundation for Business Execution. Boston: Harvard Business School Press.
16. Rosser, B. (2004). Sell the Value of Architecture to the Business (No. G00123412): Gartner Research.
17. Schulman, J. (2003). Defining 'Good Enough' Architecture (No. COM-20-2743): Gartner Research.
18. The Open Group. (2006). Architecture Governance. Retrieved November 22, 2006, from http://www.opengroup.org/architecture/togaf8-doc/arch/chap26.html#tag_27_01
19. Weiss, D., Rosser, B., & Blanton, C. (2005). Enterprise Architecture Improves IT Planning Synergies (No. G00130847): Gartner Research

Appendix C – Enterprise Architecture Concepts

Table 1. ENTERPRISE ARCHITECTURE CONCEPTS	
Enterprise Architecture Concept	[Source No.] How Concept is Related to Enterprise Architecture
Business Strategy	<p>[15] “An enterprise architecture is critical for building a foundation for execution because it maps out important process, data, and technology enabling desired levels of integration and standardization... These benefits are evident in five areas: IT costs, IT responsiveness, risk management, managerial satisfaction, and strategic business outcomes” (Ross et al., 2006, pp. 92-93).</p> <p>[15] Describes the four important strategic outcomes companies derive from enterprise architecture: (1) better operational excellence, (2) more customer intimacy, (3) greater product leadership, and (4) more strategic agility (Ross et al., 2006, p. 100).</p> <p>[16] Defines the four-step sequence for moving from business strategy to architecture (Rosser, 2004, pp. 3-4).</p> <p>[17] Every IT architecture element needs to support a specific business goal and be able to be linked to that goal in measurable terms (Schulman, 2003, p. 5).</p> <p>[19] EA is a proactive analytical process that supports strategic alignment, information gathering, governance, direction and control (Weiss et al., 2005, p. 4).</p>

Table 1. ENTERPRISE ARCHITECTURE CONCEPTS

Enterprise Architecture Concept	[Source No.] How Concept is Related to Enterprise Architecture
	[19] EA also facilitates intra-organizational communication, cooperation and sustained strategy realization (Weiss et al., 2005, p. 4).
IT Strategy	<p>[1] The CIO's office has responsibility to define the strategic enterprise architecture that provides the infrastructure for IT activities and architectures in each of the company's business units (Bieberstein, Bose, Walker, & Lynch, 2005, p. 692).</p> <p>[17] Although poor technology choices can cause architecture to fail, usually it is poor management and governance (Schulman, 2003, p. 4).</p> <p>[18] Defines IT benefits derived through continuing governance of architectures (The Open Group, 2006d).</p> <p>[19] EA parallels the IT planning processes by providing a consistent linkage between business strategy and technology implementation (Weiss et al., 2005, p. 6).</p> <p>[19] EA demands <i>creative collaboration</i> among business and IT strategists, technology implementers, and experts on market and competitive strategy (Weiss et al., 2005, p. 6).</p>
IT Governance	[2] Continued trends in rapid application development, accelerated pace of change in information technology, in organizations, in competitive

Table 1. ENTERPRISE ARCHITECTURE CONCEPTS

Enterprise Architecture Concept	[Source No.] How Concept is Related to Enterprise Architecture
	<p>countermeasures, in national security, and in the environment, has caused increasing frustration with heavyweight plans, specifications, and other documentation imposed by contractual inertia and maturity model compliance criteria (Boehm, 2006, p. 19).</p> <p>[6] “The behavior and practices of IT organizations are governed by policies, practices, monitoring and enforcement across a wide range of IT responsibilities and disciplines, such as architecture, security, sourcing, supplier selection and management, service-oriented architecture (SOA) reuse and regulatory compliance. The complete list might vary from organization to organization, but the basic activity cycle for each of these IT supply governance (ITSG) subsets remains the same: plan, implement, manage and monitor” (Gerrard, 2006, p. 6).</p> <p>[15] The five major decision areas related to IT governance include: (1) IT principles, (2) enterprise architecture, (3) IT infrastructure, (4) business application needs, and (5) prioritization and investment (Ross et al., 2006, p. 121).</p> <p>[18] Defines the characteristics of governance: discipline, transparency, independence, accountability, responsibility, and fairness (The Open Group, 2006d).</p>

Table 1. ENTERPRISE ARCHITECTURE CONCEPTS

Enterprise Architecture Concept	[Source No.] How Concept is Related to Enterprise Architecture
	<p>[18] “IT governance provides the framework and structure that links IT resources and information to enterprise goals and strategies.”</p> <p>[18] “IT governance institutionalizes best practices for planning, acquiring, implementing and monitoring IT performance, to ensure that the enterprise's IT assets support its business objectives.”</p>
IT Project Management	<p>[1] Internal technical standards are often the most visible forms of project governance (Bieberstein et al., 2005, p. 693).</p> <p>[3] Since the EA team cannot participate in every project, it must define a method to determine the level of EA scrutiny that various projects will receive (Burke, 2006a, p. 4).</p> <p>[9] Defines the types of projects that should be reviewed (Jaffarian, 2005, p. 30).</p> <p>[11] EA effectiveness is tied to project governance. Project governance is also key to aligning IT activity to business goals, cost control and providing IT value (Leganza, 2003, p. 1).</p> <p>[11] Use an integrated approach to project governance that does not encumber project delivery but still addresses architecture, alignment and cost control requirements (Leganza, 2003, p. 1).</p>

Table 1. ENTERPRISE ARCHITECTURE CONCEPTS

Enterprise Architecture Concept	[Source No.] How Concept is Related to Enterprise Architecture
	<p>[11] “If several processes are needed to address timing issues, ensure the maximum possible linkage between processes and reuse project documentation. Use the project initiation process as a trigger for architecture scrutiny” (Leganza, 2003, p. 1).</p> <p>[11] Describes five primary goals that are common motivations for creating project governance structures and processes (Leganza, 2003, p. 2).</p> <p>[11] Costs hidden by incomplete (or nonexistent) architecture analysis tend to make project ROI look better than will be actually attainable (Leganza, 2003, p. 3).</p> <p>[15] “We define the IT engagement model as the system of governance mechanisms assuming the business and IT projects achieve both local and company-wide objectives” (Ross et al., 2006, p. 119).</p> <p>[15] “By linking IT governance and project management, the engagement model coordinates and aligns. Without an engagement model, project leaders execute in isolation. They choose solutions that meet project goals, but the company’s overall goals for integration and standardization are ignored and the foundation for execution never emerges” (Ross et al., 2006, pp. 120-121).</p> <p>[19] The PMO can proactively incorporate compliance with the EA by</p>

Table 1. ENTERPRISE ARCHITECTURE CONCEPTS	
Enterprise Architecture Concept	[Source No.] How Concept is Related to Enterprise Architecture
	<p>effectively aligning EA with the PMO and focusing EA efforts on coaching and supporting project architects (Weiss et al., 2005, p. 6).</p> <p>[19] The PMO facilitates tactical execution of the IT strategic plan as well as the governance of EA future-state deployment (Weiss et al., 2005, p. 8).</p> <p>[19] “One way to measure how well EA improves project alignment and reduces project risk is to measure the benefits of involving enterprise architects to consult on and support projects” (Weiss et al., 2005, p. 9).</p>

Appendix D – Enterprise Architecture Elements

Table 2. ENTERPRISE ARCHITECTURE ELEMENTS	
Enterprise Architecture Element	[Source No.] How Enterprise Architecture Element Supports Governance
Enterprise Architect	<p>[4] “In the future, enterprise architects will influence the organization from the sidelines by tweaking the rules, changing the basic building blocks of the architecture and altering goal structures to enable emergent behavior, rather than attempting to be the central planners for every change in the organization” (Burke, 2006b, p. 3).</p> <p>[8] Defines the responsibilities of the chief enterprise architect (Handler & Weiss, 2006, pp. 3-4).</p> <p>[8] Defines the roles that can report directly to the chief enterprise architect (Handler & Weiss, 2006, p. 8).</p>
Architecture Principle	<p>[4] “The defining characteristic of emergence is that—given relatively simple components—interacting in a dynamic environment can create highly complex systems without the benefit of a hierarchical control structure. To understand what not to architect, we must understand the properties of emergent systems to recognize opportunities for creating the structures that enable emergence” (Burke, 2006b, p. 3).</p> <p>[4] “In the future, using a services-oriented architecture approach, system designers and enterprise architects will apply the principle that it is more important to managing the interfaces between services, rather than the</p>

Table 2. ENTERPRISE ARCHITECTURE ELEMENTS

Enterprise Architecture Element	[Source No.] How Enterprise Architecture Element Supports Governance
	<p>internals of the service itself” (Burke, 2006b, p. 4).</p> <p>[15] Based on case study research at 18 companies, identified the following principles for ensuring IT governance, project management, and linking mechanisms lead to successful engagement: (1) clear, specific, and actionable objectives, (2) motivation to meet company goals, (3) enforcement authority, (4) early intervention and prevention, and (5) transparent, regular, two-way communication (Ross et al., 2006, pp. 135-136).</p> <p>[16] “The resultant IT principles should become essential criteria for all technological choices. Ideally, there should be traceability from an architectural choice back to the business strategy” (Rosser, 2004, p. 4).</p> <p>[17] Defines the three principles for <i>good enough</i> architecture (Schulman, 2003, p. 2).</p> <p>[18] “Architecture principles are a subset of IT principles that relate to architecture work” (The Open Group, 2006d).</p> <p>[18] Architecture principles can be subdivided as (1) principles that govern the architecture process, affecting the development, maintenance, and use of the enterprise architecture, and (2) principles that govern the implementation of the architecture, establishing the first tenets and related</p>

Table 2. ENTERPRISE ARCHITECTURE ELEMENTS

Enterprise Architecture Element	[Source No.] How Enterprise Architecture Element Supports Governance
	guidance for designing and developing information systems (The Open Group, 2006d).
Architecture Framework	<p>[2] “These frameworks and support packages are making it possible for organizations to reinvent themselves around transformational, network-centric systems of systems” (Boehm, 2006, p. 23).</p> <p>[12] “Enterprise architecture takes a model-based approach to its fundamental challenges. Today there exists ten or so architectural frameworks for management of enterprise wide IT systems. The most renowned include the Zachman Framework for Enterprise Architecture, The Department of Defense Architecture Framework (DoDAF), The Open Group Architecture Framework (TOGAF), The Federal Enterprise Architecture (FEA), and Spewak’s Enterprise Architecture Planning (EAP)” (Lindström, Johnson, Johansson, Ekstedt, & Simonsson, 2006, p. 82).</p> <p>[12] “The models describe high-level abstractions of enterprise entities and how they relate to each other. This includes technical entities such as data, functionality, physical infrastructure, applications, and interfaces, as well as organizational entities such as business processes, goals, organizational units, and workflows” (Lindström et al., 2006, p. 82).</p> <p>[12] Two concerns ranked most important by the CIOs, the quality of the</p>

Table 2. ENTERPRISE ARCHITECTURE ELEMENTS

Enterprise Architecture Element	[Source No.] How Enterprise Architecture Element Supports Governance
	interplay between the IT organization and the business organization, and cost reduction in the business organization. Neither of these are covered by the frameworks (Lindström et al., 2006, p. 89).
Architecture Pattern	<p>[1] “IT initiatives can derive considerable amount of value from pattern-based approaches” (Bieberstein et al., 2005, p. 694).</p> <p>[1] “The business patterns are self service (user-to-business), information aggregation (user-to-data), collaboration (user-to-user), and extended enterprise (business-to-business). They are coordinated with two integration patterns: access integration and application integration” (Bieberstein et al., 2005, p. 694).</p> <p>[10] "The purpose of an architectural pattern is to provide guidelines for implementation that will ensure that new technology capabilities are constructed within the boundaries of the architecture. These guidelines are expressed at several points in the architectural process and therefore require patterns at different levels of granularity—conceptual, logical and physical” (Lapkin, 2004, p. 2).</p>

Table 2. ENTERPRISE ARCHITECTURE ELEMENTS

Enterprise Architecture Element	[Source No.] How Enterprise Architecture Element Supports Governance
Architecture Standard	<p>[1] “Internal technology standards are useful in providing templates for projects to help create standardized, readily accessible services that are easily consumable by other clients or service applications” (Bieberstein et al., 2005, p. 694).</p> <p>[4] “In these interactions, enterprise architects define interface standards for a service, and individual actors are free to make decisions over technologies that will be used on their side of the service” (Burke, 2006b, p. 2).</p> <p>[11] “EA programs’ establishment of infrastructure, application and data architecture standards explicitly address risk factors in projects. Standardization on proven technology in technical (infrastructure) architectures is in service of the goals of availability, high performance and reliability” (Leganza, 2003, p. 3).</p> <p>[15] Describes the second stage of architecture maturity know as <i>Standardized Technology</i> where companies shift some of their IT investments from local applications to shared infrastructure (Ross et al., 2006, p. 74).</p> <p>[15] “Most companies move into the Standardized Technology stage by creating a corporate CIO role or by endowing the incumbent CIO with authority to mandate IT-related behaviors. The CIO then introduces</p>

Table 2. ENTERPRISE ARCHITECTURE ELEMENTS

Enterprise Architecture Element	[Source No.] How Enterprise Architecture Element Supports Governance
	<p>efficiencies by standardizing and consolidating technology platforms and providing shared infrastructure services” (Ross et al., 2006, p. 75).</p>
Architecture Tool	<p>[1] “Enterprise repositories, such as Universal Description, Discovery, and Integration (UDDI), and approaches based on the Reusable Asset Specification (RAS), provide support for an enterprise-wide, systematic, and regulated pattern of reuse” (Bieberstein et al., 2005, p. 695).</p> <p>[1] “The service directory tool (STD) is a standards-based tool with which all services (including aggregated services) in an enterprise are described normatively and published. The services are also annotated exhaustively with key characteristics, such as service delivery guarantees, sample outputs or references, current stakeholders and team members, and ratings” (Bieberstein et al., 2005, p. 700).</p> <p>[1] “Certain services, when invoked, produce work products and assets (e.g., product binaries, architectural blueprints, best practices, and technical documents) as responses.” “These work products and reusable assets are housed and publicized by the asset directory tool (ADT)” (Bieberstein et al., 2005, pp. 700-701).</p>

Table 2. ENTERPRISE ARCHITECTURE ELEMENTS	
Enterprise Architecture Element	[Source No.] How Enterprise Architecture Element Supports Governance
	<p>[19] “The value of EA to IT asset portfolio management is in its provision of consistency across portfolios by providing life cycle planning for the entire IT asset portfolio” (Weiss et al., 2005, p. 10).</p> <p>[19] “IT asset portfolio management can also be used to support IT and EA performance metrics by validating whether or not the IT environment is evolving to be more reliable, available or cost-effective” (Weiss et al., 2005, p. 10).</p>

Appendix E – Cross Governance Interdependencies

Table 3. CROSS GOVERNANCE INTERDEPENDENCIES	
Governance Component	[Source No.] Dependency Component has to Enterprise Architecture Governance or Service-Oriented Architecture Governance
IT Organization	<p>[1] “Corporate initiatives and directives are often necessary to induce the required behaviors in a company to successfully support an enterprise-wide SOA. These initiatives include establishing IT directives for creating business transformation, creating executive councils and architecture boards, institutionalizing governance policies and models, and most importantly, allocating funds to sponsor these directives” (Bieberstein et al., 2005, p. 692).</p> <p>[1] "It is critical to specify an executive as the owner for each logically connected set of services. The owner’s responsibility is aligned with the overall enterprise governance" (Bieberstein et al., 2005, p. 693).</p> <p>[1] “Common enterprise services must have defined owners with established ownership and governance responsibilities. These owners are responsible for gathering requirements, development, deployment, the boarding process, and operations management for a service” (Bieberstein et al., 2005, p. 693).</p> <p>[7] “Software developers of all kinds will change their focus and think more about assembly than about writing new code. New development methodologies will arise, more in tune with the principles of</p>

Table 3. CROSS GOVERNANCE INTERDEPENDENCIES

Governance Component	[Source No.] Dependency Component has to Enterprise Architecture Governance or Service-Oriented Architecture Governance
	manufacturing” (Greenfield & Short, 2003, p. 18).
EA Organization	<p>[5] Describes four EA organizational models labeled as <i>Technical</i>, <i>Solutions</i>, <i>Portfolio</i>, and <i>Business</i> (Enterprise Architecture Executive Council, 2006, p. 8).</p> <p>[5] Defines the core responsibilities of EA labeled as <i>Portfolio Planner</i>, <i>Standard Setter</i>, <i>Business Enabler</i>, and <i>Transformation Agent</i> (Enterprise Architecture Executive Council, 2006, p. 9).</p> <p>[5] Defines the common EA failure paths: EA as <i>Order Taker</i>, EA as <i>Project Police</i>, EA as <i>Ivory Tower</i>, and EA as <i>Technology Incrementalist</i> (Enterprise Architecture Executive Council, 2006, p. 10).</p> <p>[8] In Gartner’s proposed new, alternative team structure for the enterprise architecture organization, each direct report to the chief enterprise architect is a “multi-disciplined architect who can take strategic requirements to resolution; a visionary with the ability to look beyond the borders of IT and view the organization as part of an extended value chain” (Handler & Weiss, 2006, p. 11).</p> <p>[15] Figure 5-3 illustrates the roles associated with different architecture practices, and how effective the roles are, as ranked by 103 CIOs. The</p>

Table 3. CROSS GOVERNANCE INTERDEPENDENCIES

Governance Component	[Source No.] Dependency Component has to Enterprise Architecture Governance or Service-Oriented Architecture Governance
	<p>results are from a 2005 study by the MIT Sloan Center for Information Systems Research (Ross et al., 2006, p. 102).</p> <p>[15] Figure 5-4 illustrates how roles associated with different architecture practices evolve as a company advances through the four stages of maturity (Ross et al., 2006, p. 103).</p>
Architecture Review Board	<p>[3] The ARB, which comprises a broad group of architecture stakeholders, including the chief architect as well as select core and virtual architecture team members, infrastructure management, application management, and business management” (Burke, 2006a, p. 3).</p> <p>[3] The executive steering committee, comprising the most-senior business managers in the organization has ultimate authority and governance over the work of the ARB and EA team (Burke, 2006a, p. 3).</p> <p>[9] Defines a governance structure (Jaffarian, 2005, p. 32).</p> <p>[11] “Implement an architecture review board as a gating factor for final designs. Project construction should begin only upon approval by the board” (Leganza, 2003, p. 1).</p> <p>[11] Implement a consultative process for EA governance if possible. The combination of the consultative review for guidance and the review board approach for approval is most effective (Leganza, 2003, p. 1).</p>

Table 3. CROSS GOVERNANCE INTERDEPENDENCIES

Governance Component	[Source No.] Dependency Component has to Enterprise Architecture Governance or Service-Oriented Architecture Governance
	<p>[14] Defines an architecture review value proposition (Maranzano et al., 2005, p. 35).</p> <p>[14] Defines five principles that form the basis of architecture reviews (Maranzano et al., 2005, p. 35).</p> <p>[14] Defines architecture review participants (Maranzano et al., 2005, p. 36).</p> <p>[14] Defines four phases of the architecture review process (Maranzano et al., 2005, pp. 37-38).</p> <p>[14] Defines an architecture review checklist (Maranzano et al., 2005, p. 40).</p> <p>[18] Defines the composition of an architecture board (The Open Group, 2006d).</p>
Corporate Culture	<p>[1] “The reuse of common IT services (both inter and intra-business units) is a critical success factor of SOA. Reuse promotes company-wide consistency of key business operations and processes, while reducing costs. It is indirectly impacted by cultural proclivities (to reuse rather than create) in the technical community and directly affected by cross-business-unit cooperation and collaboration” (Bieberstein et al., 2005, pp. 692-693).</p> <p>[1] “Changes to culture and individual behaviors are extensive when SOA is</p>

Table 3. CROSS GOVERNANCE INTERDEPENDENCIES

Governance Component	[Source No.] Dependency Component has to Enterprise Architecture Governance or Service-Oriented Architecture Governance
	implemented. Careful planning of the change is a critical success factor for the new environment” (Bieberstein et al., 2005, p. 704).
IT Culture	[18] “Conceptually, architecture governance is an approach, a series of processes, a cultural orientation, and set of owned responsibilities that ensure the integrity and effectiveness of the organization's architectures” (The Open Group, 2006d).
Architecture Maturity	<p>[15] Defines the four stages of architecture maturity (Ross et al., 2006, pp. 71-79).</p> <p>[15] Defines the management practices for realizing value from architecture maturity (Ross et al., 2006, pp. 101-109).</p>
System Development Methods	<p>[2] “A source of both significant benefits and challenges to simultaneously adopting to change and achieving high dependability is the increasing availability of commercial-off-the-shelf (COTS) systems and components. These enable rapid development of products with significant capabilities in a short time” (Boehm, 2006, p. 20).</p> <p>[2] "MDD capitalizes on the prospect of developing domain models whose domain structure leads to architectures with high module cohesion and low intermodule [sic] coupling, enabling rapid and dependable application development and evolvability [sic] within the domain” (Boehm, 2006, p.</p>

Table 3. CROSS GOVERNANCE INTERDEPENDENCIES

Governance Component	[Source No.] Dependency Component has to Enterprise Architecture Governance or Service-Oriented Architecture Governance
	<p>21).</p> <p>[7] "Development by Assembly: Application developers will build about 30% of each application. The remaining 70% will be supplied by ready-built vertical and horizontal components. Most development will be component assembly, involving customization, adaptation, and extension" (Greenfield & Short, 2003, p. 18).</p> <p>[7] "To feed the demand for components created by software factories, supply chains will emerge, creating standard product types with standard specification formats that help consumers and suppliers negotiate requirements, standard architectures and implementation technologies that let third parties assemble independently developed components, standard packaging formats that make components easy to consume, standard tools that can be reconfigured for product specific feature variations, and standard development practices" (Greenfield & Short, 2003, p. 18).</p> <p>[7] "Requirements capture, analysis and negotiation will become critical elements of customer relationship management. Service level agreements documenting the expectations of consumers and suppliers will be govern transactions. Following product delivery and acceptance, repairs and assistance will be provided on a warranty basis. In most cases, consumers will lease components from suppliers, allowing them to receive patches and</p>

Table 3. CROSS GOVERNANCE INTERDEPENDENCIES

Governance Component	[Source No.] Dependency Component has to Enterprise Architecture Governance or Service-Oriented Architecture Governance
	<p>upgrades systematically” (Greenfield & Short, 2003, p. 18).</p> <p>[7] “Developers will use tools configured for the purpose at hand. These tools will use powerful abstractions and appropriate best practices encoded as languages, patterns and frameworks for specific domains. Application developers will no longer hand craft large amounts of code in general purpose languages. Instead, they will build variants of existing products, customized to satisfy unique requirements, writing small amounts of code in domain-specific languages to complete frameworks” (Greenfield & Short, 2003, p. 18).</p>
Governance Objectives	<p>[9] Defines EA governance objectives (Jaffarian, 2005, p. 10).</p> <p>[9] Defines EA governance choices (Jaffarian, 2005, p. 25).</p> <p>[13] “SOA without governance simply doesn't deliver enough return on investment, and in most cases it kills the SOA project” (Malinverno, 2006, p. 5).</p> <p>[17] Defines the most-important aspects of governance (Schulman, 2003, p. 4).</p> <p>[18] “All architecture amendments, contracts, and supporting information must come under governance through a formal process in order to register, validate, ratify, manage, and publish new or updated content” (The Open</p>

Table 3. CROSS GOVERNANCE INTERDEPENDENCIES

Governance Component	[Source No.] Dependency Component has to Enterprise Architecture Governance or Service-Oriented Architecture Governance
	Group, 2006d).
Governance Framework	<p>[9] A governance framework drives collaboration and resolution” (Jaffarian, 2005, p. 8).</p> <p>[9] Defines a framework for decision-making (Jaffarian, 2005, p. 8).</p> <p>[9] Defines prerequisites for an architecture governance program (Jaffarian, 2005, p. 27).</p> <p>[9] Defines governance model requirements (Jaffarian, 2005, p. 30).</p> <p>[9] Defines governance processes (Jaffarian, 2005, p. 31).</p> <p>[15] Figure 5-3 illustrates the processes associated with different architecture practices, and how effective the processes are, as ranked by 103 CIOs. The results are from a 2005 study by the MIT Sloan Center for Information Systems Research (Ross et al., 2006, p. 102).</p> <p>[18] Defines the foundational elements required for architecture governance (The Open Group, 2006d).</p> <p>[18] “Governance processes are required to identify, manage, audit, and disseminate all information related to architecture management, contracts, and implementation” (The Open Group, 2006d).</p>

Table 3. CROSS GOVERNANCE INTERDEPENDENCIES

Governance Component	[Source No.] Dependency Component has to Enterprise Architecture Governance or Service-Oriented Architecture Governance
Service Level Agreements Operational Level Agreements	<p>[1] “Services are implemented with focal emphasis on satisfying the contractual interface, managed and executed in a scalable and resilient IT environment, and operated by adhering to governing policies and service-level agreements (SLAs)” (Bieberstein et al., 2005, p. 697).</p> <p>[13] “Strict governance discipline must be applied to all services.” To avoid "death by governance," introduce a simple distinction between public and private services (Malinverno, 2006, p. 1)</p> <p>[13] “Within the IT governance framework, SOA governance identifies decision making authority for defining or modifying the business processes that will be supported with SOA techniques, the service levels required, the service performance requirements, the access rights and so on. In addition, SOA governance addresses the way reusable services are defined, designed, accessed, executed and maintained. SOA governance is also an important mechanism for determining service ownership and cost allocation in a shared-service organization” (Malinverno, 2006, p. 4).</p> <p>[18] “Compliance assessments against Service Level Agreements (SLAs), Operational Level Agreements (OLAs), standards, and regulatory requirements will be implemented on an ongoing basis to ensure stability, conformance, and performance monitoring” (The Open Group, 2006d).</p>

Table 3. CROSS GOVERNANCE INTERDEPENDENCIES

Governance Component	[Source No.] Dependency Component has to Enterprise Architecture Governance or Service-Oriented Architecture Governance
Architecture Reviews	<p>[15] “Companies realizing strategic benefits from enterprise architecture have project methodologies emphasizing the importance of architecture. Successful companies involve IT architects early in project design and typically demand that projects pass an architecture compliance review. In these companies the IT architect plays a pivotal role in project implementation” (Ross et al., 2006, p. 112).</p> <p>[18] Defines architecture compliance reviews (The Open Group, 2006d).</p> <p>[18] Defines the architecture compliance review process (The Open Group, 2006d).</p> <p>[18] Defines architecture compliance review checklists (The Open Group, 2006d).</p>

Bibliography

- Anderson, V., & Johnson, L. (1997). *Systems Thinking Basics, From Concepts to Causal Loops*. Waltham, MA: Pegasus Communications, Inc.
- Apfel, A. (2006). *Role Overview: Program and Portfolio Management* (No. G00143884): Gartner Research.
- Baskinger, M., & Nam, K.-C. (2006). *Visual narratives: the essential role of imagination in the visualization process*. Paper presented at the Proceedings of the 2006 Asia-Pacific Symposium on Information Visualisation - Volume 60.
- Best Practices Council for Architecture and Planning Executives. (2004). *Demonstrating the Value of Enterprise Architecture*.
- Bieberstein, N., Bose, S., Walker, L., & Lynch, A. (2005). Impact of service-oriented architecture on enterprise systems, organizational structures, and individuals. *IBM Systems Journal*, 44(4), 691-708.
- Bittler, S., & Kreizman, G. (2005). *Gartner Enterprise Architecture Process: Evolution 2005* (No. G00130849): Gartner Research.
- Blechar, M., & Norton, D. (2006). *Determining Whether OOA&D or CBD Best Supports Reusable Software and Services* (No. G00141426): Gartner Research.
- Blevins, T. J., Spencer, J., & Waskiewicz, F. TOGAF ADM and MDA® The Power of Synergy.
- Bloomberg, J. (2004). SOA Governance: Reengineering IT Governance. Retrieved November 26, 2006, from <http://www.zapthink.com/report.html?id=ZAPFLASH-10272004>
- Boehm, B. (2006). *A view of 20th and 21st century software engineering*. Paper presented at the Proceeding of the 28th international conference on Software engineering.
- Burke, B. (2006a). *Implement an Effective Assurance Process for Your Enterprise Architecture* (No. G00141577): Gartner Research.
- Burke, B. (2006b). *What Not to Architect* (No. G00141840): Gartner Research.
- Cernosek, G., & Naiburg, E. (2004). The Value of Modeling. *The Rational Edge*, Nov.
- Chinnici, R., Gudgin, M., Moreau, J. J., Schlimmer, J., & Weerawarana, S. (2004). Web Services Description Language (WSDL) Version 2.0 Part 1: Core Language. *W3C Working Draft*, 26.
- CIMOSA Association. (2006). Standardisation. Retrieved December 17, 2006, from <http://www.cimosa.de/Standards/standard1.html>
- Clark, L., Desisto, R., Holincheck, J., White, A., & Kyte, A. (2006). *Hype Cycle for Software as a Service, 2006* (No. G00141122): Gartner Research.
- Colville, R. (2006). *Best Practices for Configuration Management: Organization, Process and CMDB* (No. G00136977): Gartner Research.
- Corporate Executive Board. (2006). *Enterprise Architecture Tools* (No. IEC15ARYLT): Corporate Executive Board.
- Dreyfuss, C. (2003). *Create a Governance Architecture That Adapts to Change* (No. COM-21-2611): Gartner Research.

- Enterprise Architecture Executive Council. (2005). 2005 State of the Function Enterprise Architecture [Electronic Version], 32. Retrieved October 27, 2006 from <https://www.cio.executiveboard.com/Members/ResearchAndTools/Abstract.aspx?cid=9735717>.
- Enterprise Architecture Executive Council. (2006). Key Developments in Enterprise Architecture, 2006 Briefing for Chief Information Officers [Electronic Version]. Retrieved December 10, 2006.
- Forrester. (2007). Corporate Fact Sheet. Retrieved January 3, 2007, from <http://www.forrester.com/FactSheet>
- Frankel, D., Harmon, P., Mukerji, J., Odell, J., Owen, M., Rivitt, P., et al. (2003). The Zachman Framework and the OMG's Model Driven Architecture. *Business process Trends*.
- Gartner Research. (2006). Best Practices Councils, Architecture and IT Planning [Electronic Version]. Retrieved January 1, 2007 from http://www.gartner.com/it/products/ep/best_practices.jsp#arch.
- Gartner Research. (2007). About Gartner. Retrieved January 3, 2007, from http://www.gartner.com/it/about_gartner.jsp
- Gerrard, M. (2006). *Defining IT Governance: The Gartner IT Governance Demand/Supply Model* (No. G00140091): Gartner Research.
- Greenfield, J., & Short, K. (2003). *Software factories: assembling applications with patterns, models, frameworks and tools*: ACM Press New York, NY, USA.
- Handler, R., & Weiss, D. (2006). *Role Definition and Organization Structure: Chief Enterprise Architect* (No. G00138141): Gartner Research.
- Heffner, R. (2002). *The Pillars of Enterprise Architecture Terminology*: Giga Research.
- IBM. (2006a). About developerWorks. Retrieved January 18, 2007, from <http://www-128.ibm.com/developerworks/aboutdw/awards.html>
- IBM. (2006b). Rational Unified Process. Version 7.0.1. Retrieved November 10, 2006, from <http://www-306.ibm.com/software/awdtools/rup/>
- International Organization for Standardization. (2006, August 2006). Overview of the ISO. Retrieved November 10, 2006, from <http://www.iso.org/iso/en/aboutiso/introduction/index.html>
- Iyer, B., & Gottlieb, R. (2004). The Four-Domain Architecture: An approach to support enterprise architecture design. *IBM Systems Journal*, 43(3).
- Jaffarian, T. (2005). *Enterprise Architecture Governance*: Gartner Research.
- James, G. (2005). *Magic Quadrant for Enterprise Architecture Tools, 4Q04* (No. G00125104): Gartner Research.
- Jonkers, H., Lankhorst, M. M., ter Doest, H. W. L., Arbab, F., Bosma, H., & Wieringa, R. J. (2006). Enterprise architecture: Management tool and blueprint for the organisation. *Information Systems Frontiers*, 8(2), 63-66.
- Kobiellus, J. (2004). *Service-Oriented Architecture: Developing the Enterprise Roadmap*: Burton Group.
- Krippendorff, K. (2003). *Content Analysis: An Introduction to Its Methodology*: Sage Publications.
- Lapkin, A. (2004). *A User's Guide to Architecture Patterns* (No. G00124049): Gartner Research.
- Lapkin, A. (2006). *Gartner Defines the Term 'Enterprise Architecture'* (No. G00141795): Gartner Research.

- Leedy, P., & Ormond, J. (2005). *Practical Research: Planning and Design* (8 ed.). Upper Saddle River: Pearson Education, Inc.
- Leganza, G. (2003). Project Governance and Enterprise Architecture Go Hand in Hand [Electronic Version]. *Giga Planning Assumption*.
- Lindström, Å., Johnson, P., Johansson, E., Ekstedt, M., & Simonsson, M. (2006). A survey on CIO concerns-do enterprise architecture frameworks support them? *Information Systems Frontiers*, 8(2), 81-90.
- Luftman, J. N., & Bullen, C. V. (2004). *Managing the information technology resource*: Pearson Education.
- Lymer, S., Liu, W., & Easterbrook, S. (2005). *Experience in using business scenarios to assess COTS components in integrated solutions*. Paper presented at the Proceedings of the 2005 conference of the Centre for Advanced Studies on Collaborative research.
- Malan, R., & Bredemeyer, D. (2002). Less is more with minimalist architecture. *IT Professional*, 4(5), 48.
- Malinverno, P. (2006). *Service-Oriented Architecture Craves Governance* (No. G00135396): Gartner Research.
- Maranzano, J. F., Rozsypal, S. A., Zimmerman, G. H., Warnken, G. W., Wirth, P. E., & Weiss, D. M. (2005). Architecture Reviews: Practice and Experience. *Software, IEEE*, 22(2), 34-43.
- Martin, R., & Robertson, E. (2003). A comparison of frameworks for enterprise architecture modeling. *ER2003-22nd Intl. Conf. on Conceptual Modeling*, 562-564.
- Merriam-Webster Online Dictionary. (2006a). Collaborate. Retrieved December 2, 2006, from <http://www.m-w.com/dictionary/collaborate>
- Merriam-Webster Online Dictionary. (2006b). Framework. Retrieved December 2, 2006, from <http://www.m-w.com/dictionary/framework>
- Michiels, C., Snoeck, M., Lemahieu, W., Goethals, F., & Dedene, G. (2003). A Layered Architecture Sustaining Model Driven and Event Driven Software Development. *LECTURE NOTES IN COMPUTER SCIENCE*, 58-65.
- Miller, J., & Mukerji, J. MDA Guide Version 1.0. 1. *Object Management Group* (2003).
- Mitra, T. (2005). A Case for SOA Governance [Electronic Version]. *IBM developerworks August*. Retrieved November 13, 2006 from <http://www-128.ibm.com/developerworks/webservices/library/ws-soa-govern/>.
- Mittal, K. (2006). SOA governance for developers and architects [Electronic Version]. Retrieved November 13, 2006 from <http://www-128.ibm.com/developerworks/ibm/library/ar-soaben/>.
- Object Management Group. (2006). About the Object Management Group™ (OMG™). Retrieved November 22, 2006, from <http://www.omg.org/gettingstarted/gettingstartedindex.htm>
- Organization for the Advancement of Structured Information Standards. (2006a). About OASIS. Retrieved November 22, 2006, from <http://www.oasis-open.org/who/>
- Organization for the Advancement of Structured Information Standards. (2006b, August 2, 2006). Reference Model for Service Oriented Architecture 1.0. Retrieved November 22, 2006, from <http://www.oasis-open.org/committees/download.php/19679/soa-rm-cs.pdf>
- Palmquist, M., Busch, C., De Maret, P., Flynn, T., Kellum, R., Le, S., et al. (2006). Content Analysis. *Writing@CSU* Retrieved October 2, 2006, from <http://writing.colostate.edu/guides/research/content/>

- Pegasus Communications. (2006a). Causal Loop Diagrams. Retrieved November 10, 2006, from <http://www.pegasuscom.com/cld.html>
- Pegasus Communications. (2006b). What is Systems Thinking? Retrieved November 10, 2006, from <http://www.pegasuscom.com/aboutst.html>
- Ross, J. W., Weill, P., & Robertson, D. C. (2006). *Enterprise Architecture as Strategy: Creating a Foundation for Business Execution*. Boston: Harvard Business School Press.
- Rosser, B. (2004). *Sell the Value of Architecture to the Business* (No. G00123412): Gartner Research.
- Saloner, G., Shepard, A., & Podolny, J. M. (2001). *Strategic management*. John Wiley New York.
- Schmidt, D., & Buschmann, F. (2003). *Patterns, frameworks, and middleware: their synergistic relationships*. Paper presented at the Proceedings of the 25th International Conference on Software Engineering.
- Schulman, J. (2003). *Defining 'Good Enough' Architecture* (No. COM-20-2743): Gartner Research.
- Schulman, J. (2004). *Architecture Patterns Lead to Better Solutions* (No. G00123458): Gartner Research.
- Sommerville, I. (2001). *Software Engineering* (6th ed.): Addison-Wesley.
- The Open Group. (2005). Introduction to Architecture Governance. from <http://www.opengroup.org/architecture/togaf8-doc/arch/p4/gov/gov.htm>
- The Open Group. (2006a). Architecture Board. Retrieved November 22, 2006, from http://www.opengroup.org/architecture/togaf8-doc/arch/chap23.html#tag_24
- The Open Group. (2006b). Architecture Compliance. Retrieved December 17, 2006, from <http://www.opengroup.org/architecture/togaf8-doc/arch/toc.html>
- The Open Group. (2006c). Architecture Description Markup Language. Retrieved December 17, 2006, from http://www.opengroup.org/tech/architecture/adml/adml_home.htm
- The Open Group. (2006d). Architecture Governance. Retrieved November 22, 2006, from http://www.opengroup.org/architecture/togaf8-doc/arch/chap26.html#tag_27_01
- The Open Group. (2006e). Architecture Principles. Retrieved December 17, 2006, from <http://www.opengroup.org/architecture/togaf8-doc/arch/chap29.html>
- The Open Group. (2006f). Business Rules and Process Management. Retrieved December 17, 2006, from http://www.omg.org/technology/documents/bms_spec_catalog.htm
- The Open Group. (2006g). Introduction to the ADM. Retrieved December 17, 2006, from <http://www.opengroup.org/architecture/togaf8-doc/arch/chap03.html>
- The Open Group. (2006h). Modeling and Metadata Specifications. Retrieved December 17, 2006, from http://www.omg.org/technology/documents/modeling_spec_catalog.htm
- The Open Group. (2006i). POSIX® 1003.1 Frequently Asked Questions (FAQ Version 1.12). Retrieved November 26, 2006, from http://www.opengroup.org/austin/papers/posix_faq.html
- The Open Group. (2006j). TOGAF 8.8.1 Part 1: Introduction. Retrieved December 17, 2006, from <http://www.opengroup.org/architecture/togaf8-doc/arch/toc.html>
- The Open Group. (2006k). TOGAF as an Enterprise Architecture Framework. Retrieved November 22, 2006, from <http://www.opengroup.org/architecture/togaf8-doc/arch/chap02.html>
- Versteeg, G., & Bouwman, H. (2006). Business architecture: A new paradigm to relate business strategy to ICT. *Information Systems Frontiers*, 8(2), 91-102.

- Weiss, D., Rosser, B., & Blanton, C. (2005). *Enterprise Architecture Improves IT Planning Synergies* (No. G00130847): Gartner Research.
- Windley, P. (2006). SOA Governance: Rules of the Game [Electronic Version]. *InfoWorld*. Retrieved November 21, 2006 from http://www.infoworld.com/pdf/special_report/2006/04SRsoagov.pdf.
- Woolf, B. (2006). Introduction to SOA governance [Electronic Version]. Retrieved November 13, 2006 from <http://www-128.ibm.com/developerworks/library/ar-servgov/>.
- World Wide Web Consortium. (2003, September 29, 2006). SOAP Version 1.2 Part 1: Messaging Framework. Retrieved November 22, 2006, from <http://www.w3.org/TR/soap12-part1/>
- World Wide Web Consortium. (2004, February 10, 2004). RDF Primer. Retrieved November 22, 2006, from <http://www.w3.org/TR/rdf-primer/>
- World Wide Web Consortium. (2006a). About the World Wide Web Consortium (W3C). Retrieved November 20, 2006, from <http://www.w3.org/Consortium/>
- World Wide Web Consortium. (2006b). About W3C. Retrieved November 20, 2006, from <http://www.w3.org/Consortium/history>
- World Wide Web Consortium. (2006c, September 29, 2006). Extensible Markup Language (XML) 1.0 (Fourth Edition). Retrieved November 22, 2006, from <http://www.w3.org/TR/REC-xml/>
- Young, C. (2005). *Organizing Tactics for Enterprise Architecture* (No. G00125756): Gartner Research.
- Yourdon, E., & Constantine, L. L. (1979). *Structured Design: Fundamentals of a Discipline of Computer Program and Systems Design*: Prentice-Hall, Inc. Upper Saddle River, NJ, USA.
- Zachman, J. A. (1996). The Framework For Enterprise Architecture: Background, Description and Utility. *Zachman International*.
- Zimmermann, O., Krogh, P., & Gee, C. (2004). Elements of Service-Oriented Analysis and Design [Electronic Version]. Retrieved November 12, 2006 from <http://www-128.ibm.com/developerworks/webservices/library/ws-soad1/>.